Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. VIII. NEW YORK, SEPTEMBER, 1903. No. 7.

ALLIS-CHALMERS CO.

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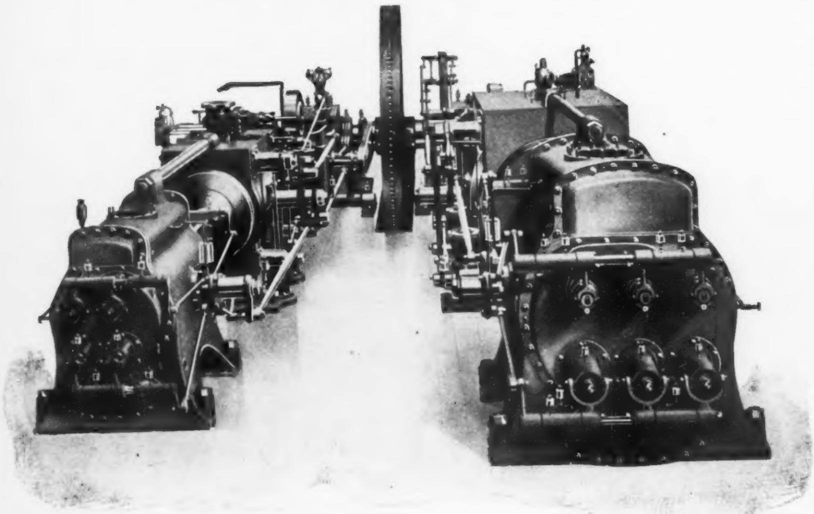

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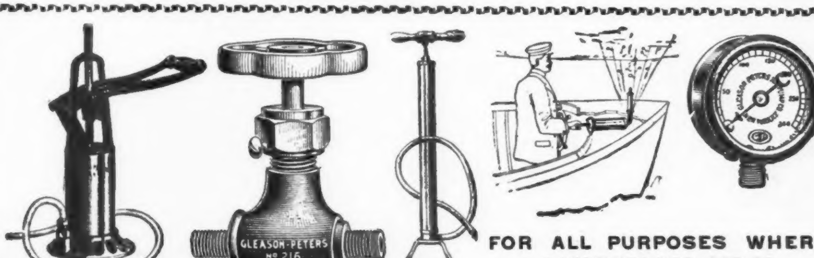
GLEASON-PETERS
Nº 216

"Compressed Air,"

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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Subscription, including postage, United States, Canada and Mexico, $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114a Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

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Compressor Explosions.

Like all good friends, the air compressor has to be properly treated or there is likely to be trouble. In the published reports of accidents of compressor plants it is usually the habit to throw the entire blame on the compressor, when, as a matter of fact, the responsibility for the accident lies with some outside agency.

A similar case is to be found in the reports of the accident which occurred at the compressor plant of the Fremont Consolidated Mining Company, Amador City, Cal., early in June, which resulted in the death of Mr. Purrington, the superintendent of the mine. According to the statement made by the management of that company, as given in the August issue of COMPRESSED AIR, the compressor was blameless. The accident, according to this statement, occurred through an error in judgment on the part of one of the employes, who attempted to cut off one cylinder of a 20¼-inch by 24-inch duplex air compressor and use the remaining cylinder as a single compressor. In his endeavor to accomplish this he closed the throttle in the discharge pipe, between the compressor and the receiver, while the machine was running. The result can be easily understood.

It is roughly estimated that the pressure reached 800 pounds to the square inch before the casting gave away. After the accident the wrecked cylinder was examined and the iron at the fracture appeared to be of good grade and flawless.

The Steam Engineer's Knowledge of Compressed Air.

The steam engineers of to-day are finding that a better knowledge of compressed air and compressed air machinery is a very important requirement for the man who is to take charge of the modern power-house and engine-room. Compressed air has come forward with surprising rapidity during the last few years, and the many practical uses to which it is now applied makes it a necessity in shops and factories where, until a short time ago, it was utterly unknown.

Compressed air power plants of considerable magnitude have been installed at mines and various mechanical establishments, and require the services of engineers with a thorough acquaintance with compressed air, as well as a knowledge of steam and other branches of engineering. In addition to these plants of major importance, there is hardly a factory or manufacturing establishment of importance that does not use compressed air in one way or another.

In places of this class where the compressed air is of secondary importance the compressor is generally placed in the engine-room, to be cared for by the engi-

neer in charge. It may be operated by steam cylinders of its own, deriving its steam supply from the same boilers as the steam engine, or it may be power driven by belt or chain. In an electric power plant electricity should undoubtedly be used to run the compressor. Where water-power is available a water wheel or turbine will easily operate it. In any of these cases, however, the air cylinders themselves require care and it behooves the steam engineer, or whoever may be in charge of the plant, to understand the construction and operation of this machinery so that he may fulfill his duties in caring for the entire plant.

The general introduction of pneumatic tools has done much to include air compressors as part of the equipment of every up-to-date machinery establishment. The wonderful saving of labor secured by their use in so many lines makes compressed air in many cases an absolute necessity if the plant is to keep abreast of the times both in capacity and cost of construction. The compressor is installed as a result. In many such cases it is not large enough to require the constant attention of one man, so it falls to the engineer to see that it is kept running.

An air compressor is a well-behaved machine when given proper attention. A machine of standard make will run with little or no trouble, provided it is given proper care. As this is as essential to the successful operation of any compressor as of any steam engine, it becomes very important these days for the steam engineer, if he desires to be successful in his line, to acquire some practical knowledge of compressed air and compressed air machinery.

The Homestake Mammoth Air Compressor.

The Homestake Mining Co., of Lead, South Dakota, has just completed the installation of its new air compressor at the Ellison Shaft and now has it in service supplying air for drilling operations underground. The compressor is one of the largest ever built, having a rated capacity, at its maximum speed, of 9,000 cubic feet of free air per minute, this amount being sufficient, under mine conditions of operation, to run fully 125 power drills.

In order to secure the necessary floor space for this monster compressor it was necessary to blast out the side of the mountain back of the Ellison Hoist, and here is located the engine-room, 37 feet by 105 feet, where the machine is in operation.

The compressor was built by the Ingersoll-Sergeant Drill Co., and is of the duplex Corliss pattern with air end of that company's well-known "piston inlet" type. The steam end is cross-compound condensing Corliss with Wheeler surface condenser and cooling tower and designed to operate under the highest economy. The air end is of the two-stage type with intercooler of large capacity for cooling the air between compressions. The dimensions of the compressor are as follows:

Steam end:

Low pressure steam cylinder, 60-inch diameter by 72-inch stroke.

High pressure steam cylinder, 32-inch diameter by 72-inch stroke.

Air end:

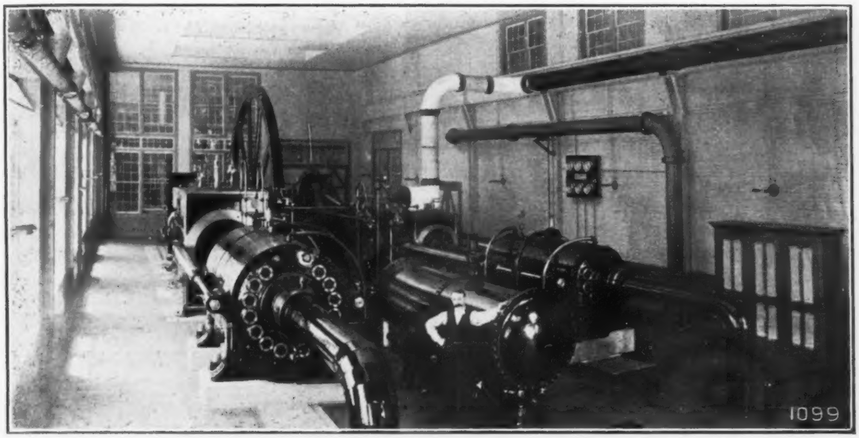
Low pressure "piston inlet" air cylinder, 52¼-inch diameter by 72-inch stroke.

High pressure "piston inlet" air cylinder, 32¼-inch diameter by 72-inch stroke.

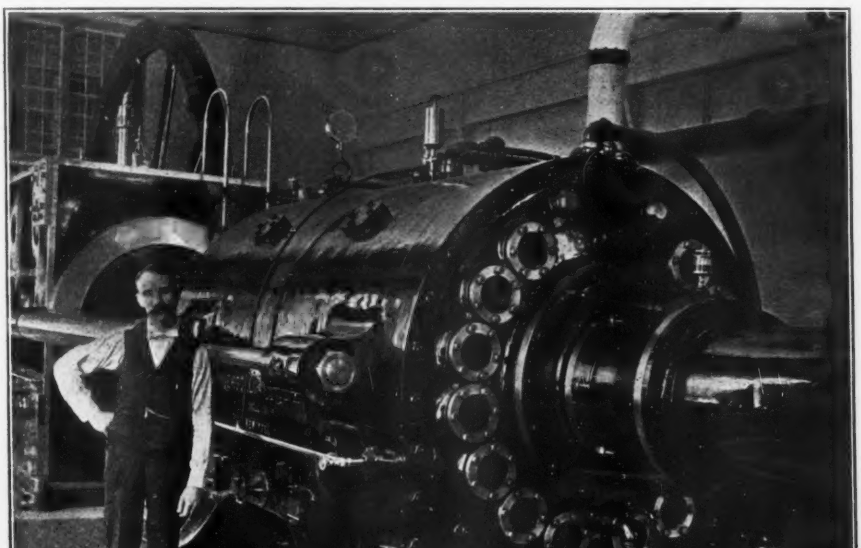
The total weight of this machinery is nearly 600,000 lbs., the flywheel alone weighing 50 tons.

On entering the engine-room one is greatly impressed with this grand piece of machinery at work and also with the superior manner in which it is installed, indicating the highest order of mechanical ability in the engineering department of the Homestake Co.

There are two other air compressors furnishing air underground at this mine. Both of these machines are of the duplex Corliss pattern with "piston inlet" air cylinders. One is located at the Old Abe Shaft and has steam cylinders 24-inch diameter by 60-inch stroke and air cylinders 26¼-inch diameter by 60-inch stroke. The



INGERSOLL-SERGEANT AIR COMPRESSOR JUST INSTALLED BY THE HOMESTAKE MINING CO.



LOW PRESSURE AIR CYLINDER ON THE NEW COMPRESSOR JUST INSTALLED BY THE HOMESTAKE MINING CO.

other is at the Highland Shaft and has steam cylinders 20-inch diameter by 42-inch stroke and air cylinders 22¼-inch diameter by 42-inch stroke. These two compressors, together with the new machine at the Ellison Shaft, furnish air for the operation of about two hundred Ingersoll-Sergeant rock drills in the mining operations underground.

Adjoining the engine-room of the large compressor is that of the Ellison Hoist, and here is installed, in marked contrast with the large machine, one of the smallest "piston inlet" compressors built. This little machine is of the following dimensions:

Two simple steam cylinders, each 10-inch diameter by 12-inch stroke.

Low pressure air cylinder, 16¼-inch diameter by 12-inch stroke.

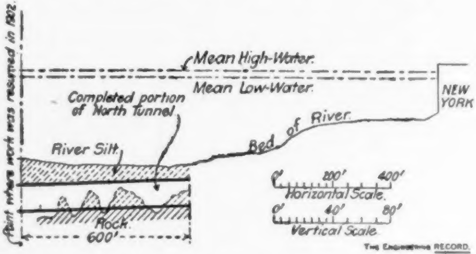
High pressure air cylinder, 10¼-inch diameter by 12-inch stroke.

The air from the above compressor is used to operate the air cylinders, furnishing the power to start, stop, reverse and apply the brakes to the Ellison Hoist.

Under the same roof is a third air compressor, of the three-stage type, also built by the Ingersoll-Sergeant Drill Co. This furnishes air at 900 lbs. pressure for the air haulage locomotive distributing ore from the shafts to the various mills.

The Hudson River Tunnel.

The Hudson river electric railway tunnel from the foot of Fifteenth street, Jersey City, to the foot of Morton street, New York, will have two parallel tubes about 15 and 18 feet in diameter. At the New Jersey end there will be two approaches, one from the Pavonia Ferry and the other from a point near the ferry of the Central Railroad of New Jersey. With these facilities and connections with the lines of the North Jersey Sreet Railway Company, which serve the Jersey City railroad terminals, the Metropolitan Street Railway and the Jersey City, Hoboken and Paterson Street Railway, the tunnel will be able to afford rapid and direct transportation for a large number of passengers between New York and New Jersey and will avoid the delays to which the ferry-boats are subjected by fogs and congested traffic. The tunnel was first promoted by the late Col. De Witt C. Haskins, who started work in 1874. Work was continued intermittently until 1882, when, after constructing about 2,000 feet of the north tube of the tunnel,



PROFILE OF FINISHED CONSTRUCTION.

the original company suspended operations. An English company was organized to carry on the work and abandoned it after 600 feet of the south tube had been completed. Finally the New York and New Jersey Railroad Company was incorporated with a capital stock of $8,500,000, and has resumed work on both tubes of the tunnel, which it is hoped will be completed without further interruption.

The tunnel will have a maximum depth of 102 feet below water level. The distance from the tunnel to river bottom varies from 5 to 65 feet, and the tunnel is driven at a grade of about 2 per cent. When work was commenced there were few precedents of such construction on a large scale under similar conditions; and as the conditions were very difficult, the work was costly and dangerous, and it has been reported that over $4,000,000 were expended upon it. It was originally known as the North River tunnel, and the work was in charge of some of the first men in this country to use the pneumatic process. A shield was not at first employed and the attempt to excavate the very fine soft silt in a large heading eventually caused a disaster which cost many lives. The excavation was made under pneumatic pressure and the cast-iron lining segments were fitted into position as rapidly as possible, so as to leave the least possible amount of unsupported earth and silt. Great difficulty was found in keeping up the pressure, as the earth was not dense enough to retain the air

thoroughly, and its escape was immediately followed by an inflow of water. This was always preceded by a hissing sound which gave warning so that the men could usually stop the hole with clay before the water commenced to enter. On one occasion a leak suddenly developed which was so large that it was impossible to stop it with the clay and straw at hand, because they were immediately forced through the opening by the air pressure. In this emergency Capt. John Anderson, the superintendent, with great heroism, placed his body in the opening and remained there until his assistants could insert clay between him and the earth and gradually close the dangerous leak. Later on a large leak occurred and before all the men could escape, the door of the air-lock became jammed so that it could not be operated and the remainder of the men working there were drowned. These events happened many years ago under the earlier administration, but they are of interest as showing the perils which were met, and the great advance in methods and appliances which have since been made and prevent the danger of future accidents of a similar nature.

The principal difficulty in the construction lies in the very soft silt which has to be penetrated, the very thin roof which is left over the tunnel, and in the fact that the surface of the bed rock is so irregular that in some cases the tunnel is partly in rock and partly in silt. No large tunnel has previously been built with a shield working partly in silt and partly in rock, and the work which is now in progress by this method is consequently of special interest.

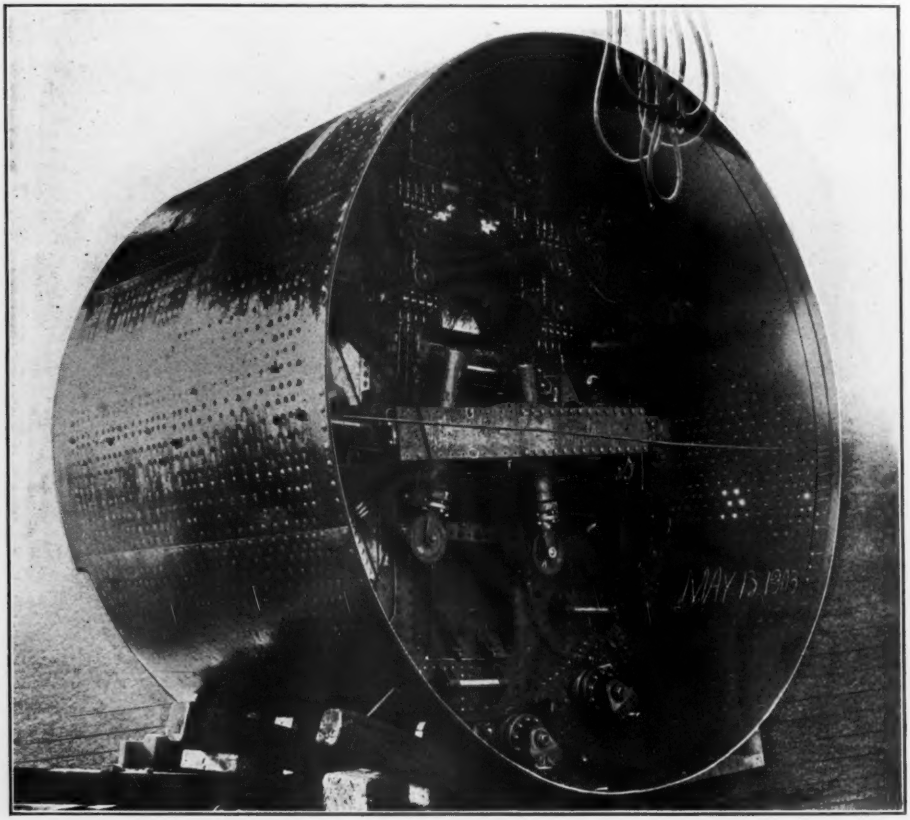
The shaft at the west end of the north tunnel is 30 feet in diameter and 65 feet deep. It is lined with brick and is enclosed in the power house where the operating plant is installed. The north tunnel has a clear internal diameter of 18 feet 1¼ inches and an external diameter of 19 feet 5¼ inches. The south tunnel has corresponding diameters of 15 feet 3 inches and 16 feet 7 inches, and both are built with cast-iron linings or shells, made with segmental plates flange-bolted together. The north tunnel shell is composed of rings 20¼ inches long, each of them having eleven segments and a key 11 inches long at the crown. The segments have a web 1½ inches thick and flanges on all sides 8 inches deep over all and about 2¼ inches thick at the base. They are slightly tapered and have parallel bearings for steel bolts 1¼ inches in diameter. The inner edges of the flanges have wedge-shaped clearances for packing and the flanges are stiffened by transverse ribs or webs about 10 inches apart and 1 inch thick. Through the centre of each segment there is a grout hole 1¼ inches in diameter which is closed with a screwed plug. The weight of one ring, 20¼ inches long, is about 12,765 pounds, which is equivalent to 7,565 pounds per linear foot, the segments thus weighing a little more than 1,100 pounds each. The lining for the south tunnel is composed of similar rings 24 inches long, each made with nine segments and a key and weighing 11,340 pounds, equivalent to 5,670 pounds per linear foot. Each circular joint in the south tunnel lining has 67 bolts and each longitudinal joint between segments has four bolts.

Work was abandoned on the construction of the north heading of this tunnel by Messrs. S. Pearson & Sons, contractors, in 1891, and the tunnel was made secure and allowed to gradually fill with water. The work on the south tunnel, after having been driven for some 550 feet of the New Jersey shaft, was abandoned, bulkheaded and closed up in 1882.

At the time of the abandonment by Messrs. Pearson & Sons, the north tunnel had been driven 3,895 feet in the direction of New York. In the latter part of 1896 and the early part of 1897 the bondholders took possession and gave instructions to have the tunnel freed of water, for the purpose of examining its condition. On completion of this work, it was found that the work previously done, with the exception of some 470 feet, was in a satisfactory condition and reorganization then proceeded, during which time the tunnel was maintained, regularly pumped and kept in good condition until in April, 1902, orders were given to prepare to proceed with the construction work. The plant which had been installed on the New York side of the river had been entirely removed, the shaft allowed to fill up, the top was covered and it was completely abandoned. At the New Jersey shaft the existing buildings were of light wooden construction, and the

machinery installed therein was for the most part out of date and in very bad condition. It was decided to make a complete sweep of all the existing plant and to remodel the whole installation with an entirely new and modern equipment for safe and rapid construction, and at the same time to build the plant work itself under its own chief engineer.

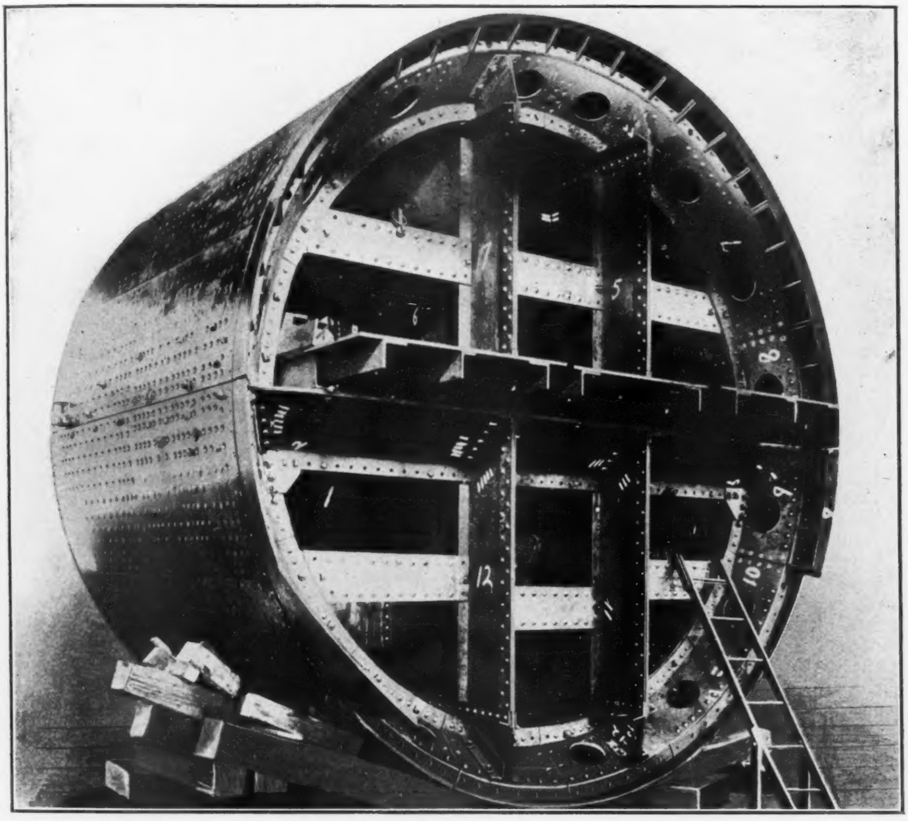
A steel frame building, constructed by the American Bridge Company, was covered with corrugated iron and divided internally for the various offices and dressing rooms necessary for carrying on the work and to accommodate the machinery installed on the surface.



REAR OF SHIELD, SHOWING JACKS, VALVES AND SEGMENT ERECTOR.

fireproof, so that there might be no danger to the works from fire at the surface buildings. Plans and specifications were drawn for the completion of the works, and although eleven bids for the new construction were invited, only one was received. This tender was not considered satisfactory, and the company then decided to carry out the construction This included four 150-horse-power locomotive type boilers, working at a pressure of 100 pounds per square inch; two 400-horse-power Berryman feedwater heaters; two Ingersoll-Sergeant straight line piston inlet air compressors, having a 22 by 24-inch steam cylinder and a 26¼ by 24 inch air cylinder to supply air inside the locks; and a

22 by $26\frac{1}{4}$ by 24 inch reserve Ingersoll-Sergeant duplex compressor for alternate duty with those above; one $20\frac{1}{4}$ by 30 inch Ingersoll-Sergeant straight line piston inlet compressor, installed for operating compressed air at high pressure, for use in running rock drills and the haulage engines installed in the tunnel. Each compressor has a 48-inch air receiver 15 feet long. The General Electric Company installed an entirely new electric lighting plant, with four 25-kilowatt marine type direct-driven generators, each wound for 125 volts pressure and operated on the three-wire system, and having a capacity sufficient for carrying on work in both the north and south tunnels. A 10 by 20 inch double-cylinder Lidgerwood hoisting engine with reversing gear and double drums was installed to operate the balanced cages in the shaft. For the operation of the shield in the tunnel duplicate 16 by 2 by 12 inch hydraulic pumps were installed and connected to an accumulator carrying a constant pressure of 1,750 pounds per square inch. The pumps and the pipe lines in the tunnel are efficient for a pressure of 5,000 pounds per square inch, and the valve arrangements permit of cutting out the accumulator pressure and pumping directly on the tunnel pressure line, to attain any pressure between 1,750 and



FRONT OF NEW SHIELD, SHOWING MOVABLE CANTILEVER PLATFORM.

5,000 pounds. The hydraulic pipe line in the tunnel is 2 inches in diameter at the pumps and is reduced in two stages to 1½ and 1¼ inches at the face. There is a 5-inch pipe line and a 4-inch air pipe line in the tunnel for pneumatic pressure for the locks, and a 3-inch pipe for the high pressure for the drills. Two of the old air-locks in the tunnel were removed and two are retained for the two-stage system. They maintain a constant pressure of 15 pounds inside the first lock and the varying additional working pressure beyond the second lock.

The shield built and installed by Messrs. Pearson & Sons has been overhauled and altered in many respects, and in its present condition is being used for the north tunnel with entire satisfaction. This shield, however, was designed for use only in the Hudson river silt and was not originally adapted for use when rock occurred at the invert and silt over the arch. Construction was therefore suspended after it had been advanced a short distance, and an excavation was made in the front of the shield, in which an apron was built. This extended 6 feet in advance of the face of the cutting edge and reached from side to side of the shield itself. It was built of 12-inch I-beams and ¾-inch steel plates, riveted solid with the shield itself and heavily stayed. Under it the sides and face of the excavation were heavily timbered and closely poled. The apron permits the advance of the shield in all cases where the rock does not extend 6 feet above the lower part of the cutting edge. The apron thus affords a 6-foot shelter for the men drilling and excavating the rock below it, and, in the chief engineer's opinion, has given absolute satisfaction in its operation.

The shield measures 19½ feet inside of the tail piece and is advanced with sixteen 8-inch hydraulic jacks. The pressure developed in the jacks corresponds with the amount necessary to push the shield forward, and varies day by day, according to the character of the soil. The cast-iron lining plates are assembled in the rear of the shield by a double-acting radial hydraulic erector, with hydraulic swivelling gear. The erector is independent of the shield and is moved forward as needed.

The north tunnel is equipped with a cable hauling system installed by the John A. Roebling's Sons Company, Mr. S. A. Cooney engineer. This is built in three independent sections, which are separated by the air-locks. The first section, 1,575 feet long, reaches from the foot of the shaft to the first air-lock; the second section, 1,660 feet long, reaches from the first to the second air-lock; and the third section extends, with a variable length, from the second air-lock to the working face. Each section is operated by an 8¼ by 10 inch special hoisting engine, built by the Lidgewood Manufacturing Company for this service, according to the requirements of the Roebling Company. The engines are designed for continuous winding and built with double-grooved drums and operated by air at 70 pounds pressure, except for the first section, which is operated with steam direct from the boilers. The first two engines exhaust to the open air, the third one, beyond the second lock, exhausts under the intermediate tunnel pressure.

A temporary wooden floor is built through the tunnel on its horizontal diameter, and on it are laid two 21-inch tracks, about 5 feet apart on centres, which reach from the shaft to the working face. In the bottom of the shaft the engine for the first division of the cable system is set on the working platform, with its axis at right angles to the tracks. The hauling cable for the first section is carried on friction sheaves from the engine to the air-lock, where it engages a horizontal sheave and returns to the hoisting engine, both parts lying on the centre lines of the tracks. At the engine the cable is adjusted by a gravity tension carriage, which allows 5 feet take-up. Both tracks converge to the doors at both ends of the single lock. There is a permanent track carried through the lock and it connects with the tunnel tracks by short sections, which are removed by hand when the lock doors are closed. The cars are pushed into and out of the lock by hand to engage the cable traction just outside the lock. The second lock is a double one, with the 3½ by 4½ foot doors in line with the centres of the tunnel tracks. The second cable section is similar to the first, except that its engine has the axis parallel to the tracks and is seated alongside on the platform close to the pressure end of the first lock. The third section is operated by an engine located just beyond the second

lock, under the track platform. The axis of this engine is at right angles to the tracks, and the rope leaving the drums is deflected over a vertical longitudinal sheave and passes down the centre horizontal deflecting sheaves, and the bight is brought back parallel with and underneath the tracks to a point at first located near the heading 700 feet away from the engine. Here it engages a

EXCAVATING UNDER TEMPORARY COVER IN FRONT OF SHIELD, HUDSON RIVER TUNNEL, NEW YORK.

of one track to the heading, where it engages two horizontal sheaves and returns to the air-lock in the centre of the other track. Here, instead of going directly to the drum, it is led around vertical sheave in the gravity tension carriage, and returns from it to a horizontal sheave near the air-lock, around which it passes to the drum, thus completing the circuit and providing be-

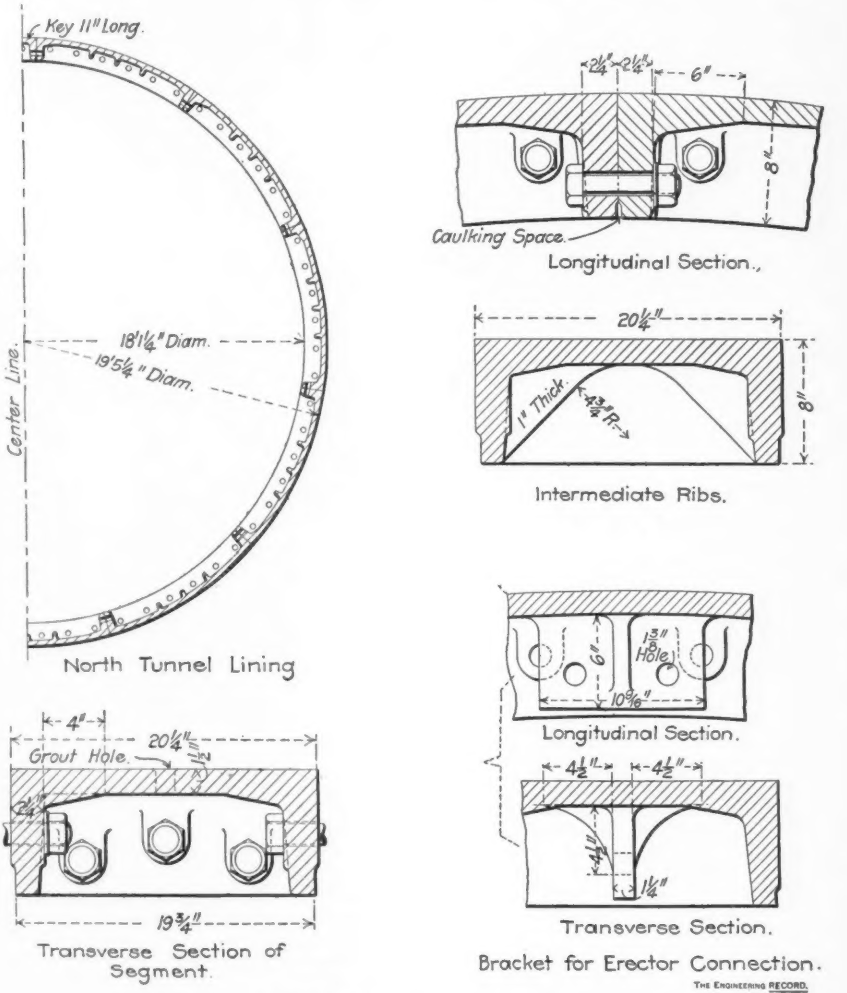
tween the tracks two hauling parts, which may, without moving the engine, be lengthened or shortened by making a corresponding displacement of the tension carriage, thus enabling the haulage system to be extended 700 feet as the heading advances. All of the machinery and all the cable, except what lies between the tracks to receive the car grips, is underneath the temporary platform. The deflecting sheaves at the heading are rigidly attached to a 10-foot section of the tracks, which also carries at the front end a solid platform plate, with guides converging to the ends of the track rails, so that when a car is pushed beyond the end of the track to receive its load the guides centre it on the track without trouble. The platform plate is horizontal, but the 10-foot rails connecting it with the main track are inclined upwards at a grade of 5 per cent., to allow room below for the deflecting sheaves and also to serve as a check and absorb the velocity of the empty cars released from the cable. When the heading has advanced from 10 to 20 feet beyond the end of the cable system, the tension carriage below is moved back a corresponding distance and the movable section of the track and front platform are moved forward on the working platform and secured there ready for continued service, the whole operation being easily and quickly made, and not requiring special adjustment. After the heading has advanced 700 feet beyond the point where the cable system was installed, another length of rope can be spliced to the 3,000 feet at first used, and the system continued indefinitely.

At each end of each division of the rope system, the returning rope is provided with a stop which engages a lever in the car grip and releases it so that the car is automatically stopped on its arrival. The departing rope is carried on two guide rollers 20 feet apart, which can be raised by a lever so as to throw the rope against the open grip on the car. Two men are required at each end of each division, one of them to raise the cable and the other to operate the grip on the car. No hand work is required to release the car from the cable. There are about 40 steel cars, each weighing 1,400 pounds and having a capacity of 2,600 pounds. They are fitted with toggle grips adapted from those used by the Roebling system of aerial tramways. The grips have adjustable jaws, made to take up the wear, and are operated by two levers, a long one, set by hand, to engage the cable, and a short one, moved by an automatic stop, to release it. Both of them are set against adjusting screws, which hold them at a point just past the centre of the toggle, so that when set they remain in equilibrium. The ropes are driven at a speed of 300 feet a minute, and the system has a calculated capacity of 300 tons in ten hours. At the west end of the tunnel the track has a grade downward away from the shaft, but at the east end the cables have to pull the cars up an incline of about 2 per cent.

The new air-locks have been installed in the south tunnel, the required machinery is under contract, and it is expected that the construction of the tunnel will be resumed in September. The shield was designed by Messrs. Jacob & Davies, and is being built by the Watson-Stillman Company. It is of special construction, as shown by the accompanying illustrations, made from photographs taken in the shop. It is stiffened by vertical and horizontal frames and by transverse diaphragms, and is provided in front with a movable cantilever working platform, which may be protruded beyond the cutting edge if necessary. In the rear are arranged the hydraulic jacks, valves and other mechanism necessary for moving the shields and for operating the erector, which is a diametrical arm concentric with the shield and commanded by hydraulic apparatus. It receives the segments, which have special brackets for connection with it, and sets them in place inside the tail of the shield. Special tools and apparatus have been furnished by the Watson-Stillman Company and by the Cockburn Barrow and Machine Company. The construction work has been somewhat irregular, on account of the great difficulties and the obstacles encountered. Some of the rock has given considerable trouble. The conditions have been severe for the workmen, and the lengths of the shifts have been reduced from four to three hours as the maximum pressure increased to 48 pounds. A medical expert is in attendance, and the men conform to careful regulations concerning work and diet. A hospital has been provided and prompt atten-

tion is given to any case of the bends. Since the installation of the cable service the men are taken to the heading in the cars, and thus save 20 minutes of the time formerly required to make each trip.

recently executed has been between 4 and 5 feet per day of finished tunnel, built under exceptionally difficult and hazardous conditions, with 65 feet of water and only 10 feet of soft silt over the crown of the tunnel.



DETAILS OF CAST-IRON LINING.

Since the operations have been resumed, work has progressed actively, with the one exception of delay caused in changing and altering the shield. Progress in rock and silt on the work

The authority of the New York Department of Docks has been given to occupy surface over the old shaft, for construction purposes. A fireproof steel building, 80 feet square, will be erected

for the accommodation of workmen and for the installation of the machinery, similar to that on the New Jersey side. The shafts, however, are different, as the one on the New Jersey side is an open one and the headings are reached through horizontal air-locks in the tunnel, while on the New York side, instead of sinking an open shaft, a closed caisson was sunk and access was had to it through a small steel shaft, terminating in a T-shaped air-lock at the bottom. This shaft is too small for the new workings, and will be torn out and replaced by a larger one, with a T-shaped air-lock above the surface. A hoisting cage will be operated inside this shaft for the removal of the excavated material in cars and for taking supplies into the tunnel. This plant will be used for the construction of that portion of the approaches which is to be lined with cast-iron plates, and from it will be driven the river portions of the tunnel to meet the headings from the New Jeresy shaft. A second shield, similar to the one described, is now under construction, and will be operated from this plant.

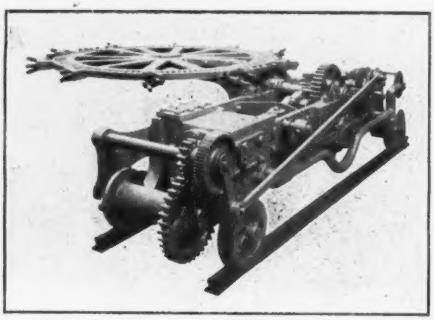
The entire work of construction is under the direction of Mr. Charles M. Jacobs, M. Inst. C. E., who is chief engineer for the New York and Jersey Railroad Company, and also for the contractor, the Hudson River Improvement Company.—*Engineering Record.*

The Diamond Coal Cutter.

Reference has been made in Compressed Air to the Diamond Coal Cutter, better known perhaps as the "Garforth," out of respect for its inventor, and to its use in the coal mines of England, but no description of the machine itself has yet been given in this publication, nor has any attempt been made to tell of the circumstances that led up to its introduction.

Mr. W. E. Garforth, M. I. C. E., F. G. S., was managing director of Pope & Pearsons' West Riding Colliery, when he was confronted in the working of his collieries by two problems. There was the ever present question of the workman, and he wished to get his coal without the use of explosives. Coal cutting by machinery was not entirely new in England, any more than it was in the United States, and he determined to attempt to solve his problems by utilizing machinery in the mines. He obtained samples of every coal-cutting machine that was then on the market, and gave them all a trial. Not finding that any of them answered exactly his requirements, he set about constructing one with the aid of the experience he had so gained, and thus evolved the Diamond machine. In this he had the assistance of several practical mining engineers, who were working with him at the time.

The Diamond machine has the usual rectangular framework common to nearly all coal-cutting machines of the long wall type. The cutting is done with the assistance of a disc, which is supported by a strong bracket standing out in the middle of the length of the machine, the bracket being securely bolted to the middle of the inner side of the frame, and the disc being supported at its centre and over a portion of its inner periphery,



DIAMOND COAL CUTTER FOR MAKING CUT ABOVE THE FLOOR.

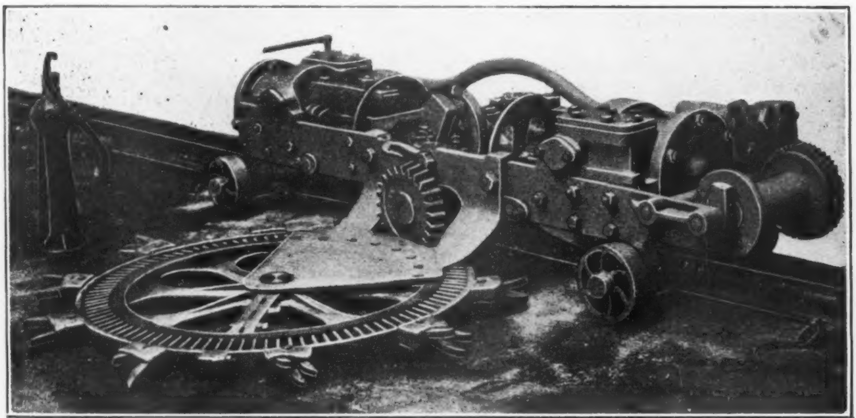
the latter by a brass arc which is bolted to the bracket and which runs within a groove in the periphery of the disc. It is in the driving arrangement that this machine differs particularly from others of the disc type. In place of a single air cylinder at one end of the frame, there are two fixed, one at each end, using air at 40 to 50 pounds pressure per square inch. Where the machine is electrically driven the motor is divided into two of smaller size, one located at either end. The machine is made to cut at floor level, the frame running

directly on the floor of the mine for that purpose, but it can also be adjusted, by shifting the bracket supporting the disc, so that the undercutting may be done at any height desired.

The coal-cutting machine is set on two rails along the coal seam which is to be undercut. There are three sets of rails and, as the machine passes from one pair to the next, the first pair is removed and placed in front. In addition to the wheels which rest on the rails a portion of the machine near the coal face is supported by two flat-faced wheels, which run on the ground, giving the machine three sets of supports instead of two, as is customary. In case of any cutting down, should the machine be lifted off the rail farthest from the coal face, it is still supported by the flat-faced wheels and those on the rail nearest the coal face.

The large wheel or disc cuts horizontally in any part of the vein most desirable or in the fire clay underneath the solid coal, and as the earth beneath the seam is cut out to uniform depth of a few feet, the machine draws itself along the rails and sprags are introduced behind the wheel to support the coal. The coal in most of the deep mines in England is induced to fall by its own weight, as soon as the sprags are withdrawn, and the falls, it is said, invariably have a larger percentage of large coal and less of crushed or small coal than under the old-fashioned pick cutting system, while the necessity of the blast, with its accompanying dangers, is almost eliminated.

In thick seams the machine is usually run in one direction only, although it is fitted with reversible gear, which is often found useful to enable it to be withdrawn should a fall occur, preventing its forward movement. After it has completed a cut (which may be of any length, from 500 to 1,500 feet long) it is brought down to the gateway and back around to the same starting point. It is mounted on a specially designed flitting arrangement, with the wheels placed within a short distance of each other, which is to overcome any difficulty with respect to the removal of the machine. In thin seams the machine cuts backward and forward, thus saving the extra cost of making head room to flit the machine. In this way the whole district is worked out before the machine is removed. In one instance the machinery had been regularly at work, going backward and forward on a long wall face, and was not removed for a period of four years, or until all the coal in that district was worked out.



DIAMOND COAL CUTTER FOR UNDERCUTTING AT LEVEL OF FLOOR.

The machine has been in use in a number of collieries and has, like other coal-cutting machines, demonstrated its ability to increase the output and at the

same time reduce the cost. Mr. Garforth's trouble with his workmen was thus successfully overcome in that, with the aid of the machine, he was able to pay better wages and increase his output materially.

While making an investigation of the conditions in the English coal mines, Mr. L. J. Daft, of New York, who has as extensive an acquaintance with the American mining methods as any man in this country, said, concerning the Diamond or "Garforth" machine:

"I found the Garforth built almost exactly the same as the old well-known Gillet & Copley machine, which has been built at Barnsley, England, for many years, except that it has more powerful cylinders, and the disc on which the cutting bits are inserted is made sufficiently large in diameter to undercut 5 feet deep. I also noticed that it makes a higher curve or undercut, and hence, if cutting in coal makes more slack, at the same time making more room for the coal to roll out in good shape. In this instance the machine was doing the undercutting in a strata of bastard coal and slate, some 6 or 7 inches thick, which lies immediately beneath the coal seam. It was taking out virtually the whole of this dirty band, which left ample height for the coal to fall, and which did fall, too, shortly after it had been undercut.

"It was doing its work rapidly, but I think I noticed that the strain on the machine, owing to the increased diameter of the cutting disc, was greater than on other machines having smaller discs, and, consequently, the repair bills on this machine will no doubt be greater. This, however, is an unimportant matter, when you take into consideration its marked increased capacity, which by far outweighs the question of repairs. I considered this the best long wall machine I have ever seen in operation.

"They have a number of these machines working in this particular seam, and in connection with which the Ingersoll machine is now being used for driving some of the headings, and preparing the territory for the operation of the Garforth machine."

Accompanying this sketch are two illustrations of this machine, one showing it prepared for undercutting at the level of the floor, and the other for undercutting in the centre or top part of the vein. In the first will be noticed that the machine stands very low, its height being less than 2 feet, which is of considerable advantage when working where there is little space. Besides being capable of working in thin veins, it requires but 2 feet 9 inches between the props or pack walls and the coal face.

Electro-Pneumatic Operation of Blast Furnace Bells.

One of the latest achievements in the operation of blast furnaces is the dispensing with workmen on the furnace top. There are more desirable places to work than on the top of a blast furnace, and a number of recent accidents have fully demonstrated that it is dangerous as well as undesirable. Modern furnaces are no longer charged by hand barrows hoisted to the top and then dumped into the hopper by a crew of men; they are charged by mechanical means, the machinery being operated at the bottom of the furnace.

To a great extent the single bell and hopper has been supplanted by the double bell and hopper, and where this has been done the efficiency of the furnace has been increased by the saving of the gas that formerly escaped from the top of the furnace every time the bell was lowered.

The use of two bells has led to a more perfect means of operating them.

When two bells are used it is always desirable that one should be closed before the other is opened, and this should be done without any liability of failure on the part of the apparatus, or any mistake made by the operator.

The Union Switch & Signal Company, of Swissvale, Pennsylvania, manufactures an electro-pneumatic apparatus that accomplishes this in a most satisfactory manner. It is strictly interlocking, and one bell cannot be lowered until the other is in place.

This company has just finished installing this apparatus on six furnaces for the Lackawanna Steel Company, of Buffalo, N. Y. These are the largest and most modern furnaces in the country, and are the first to be equipped with apparatus of this kind.

The equipment in general is shown by cuts 6 and 7, taken from the top of the furnace, and at the skip hoisting-house at the bottom; it is shown in detail by Figures 1, 2, 3, 4 and 5.

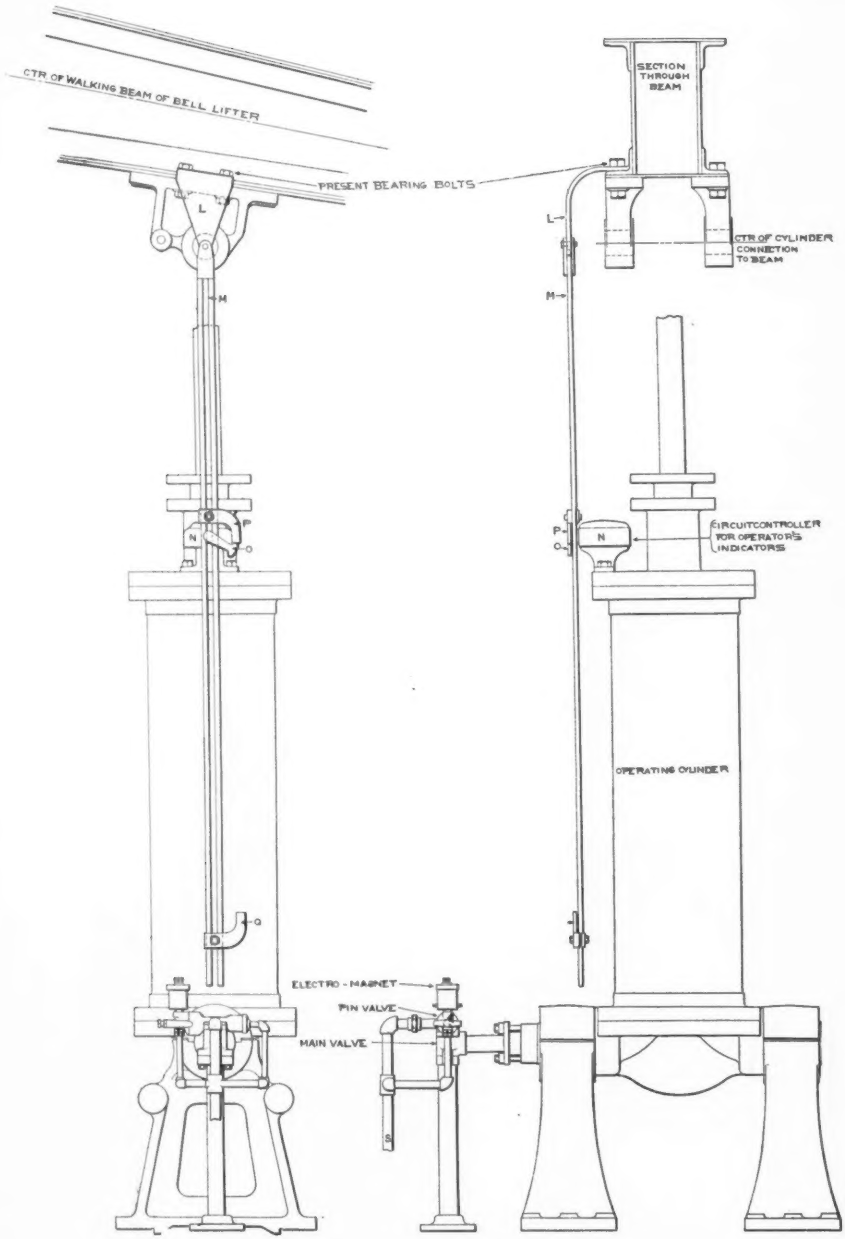

CTR OF WALKING BEAM OF BELL LIFTER
PRESENT BEARING BOLTS
SECTION THROUGH BEAM
CTR OF CYLINDER CONNECTION TO BEAM
L
M
P
N
O
Q
CIRCUITCONTROLLER FOR OPERATOR'S INDICATORS
OPERATING CYLINDER
ELECTRO - MAGNET
PIN VALVE
MAIN VALVE
S

FIG. 1.

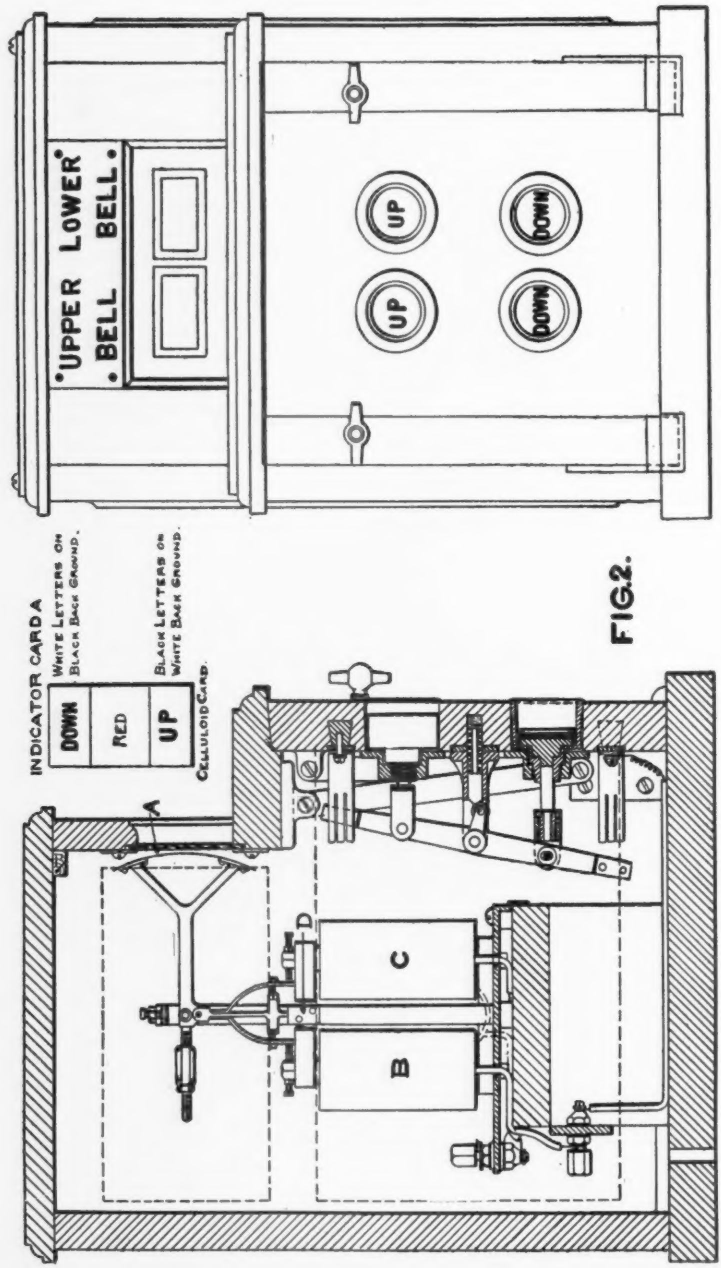

"UPPER BELL"
"LOWER BELL"
UP
UP
DOWN
DOWN
INDICATOR CARD A
DOWN
RED
UP
White Letters on Black Back Ground.
Black Letters on White Back Ground.
Celluloid Card.
A
B
C
D

FIG.2.

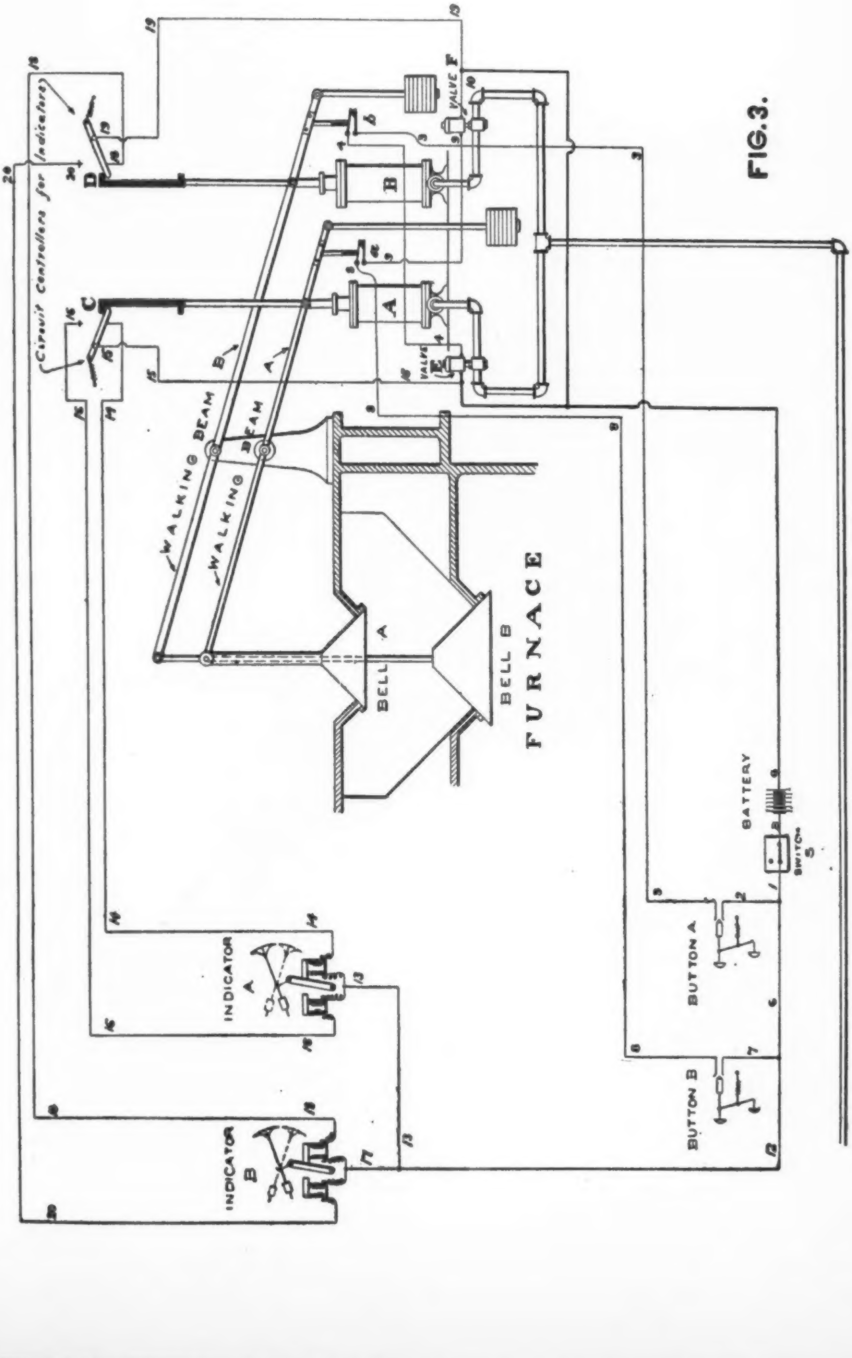

WALKING BEAM
WALKING BEAM
BELL A
BELL B
FURNACE
Circuit Controllers for Indicators
VALVE E
VALVE F
INDICATOR A
INDICATOR B
BUTTON A
BUTTON B
BATTERY
SWITCH S

FIG.3.

Figure 1 shows the device as it is connected to the operating air cylinders used to lower the bell at the top of the furnace.

Figure 2 shows the push button apparatus used to operate the valve mechanism. This is placed, together with a storage battery, switches, etc., in the skip hoisting-house at the bottom of the furnace.

As shown in Figure 1, the valve operating device is located at the bottom of the operating cylinders. The duty of this valve mechanism is to open and close the air valve leading to the operating cylinders. The operating cylinders are single acting, taking air at the bottom of the piston only; this raises one end of a

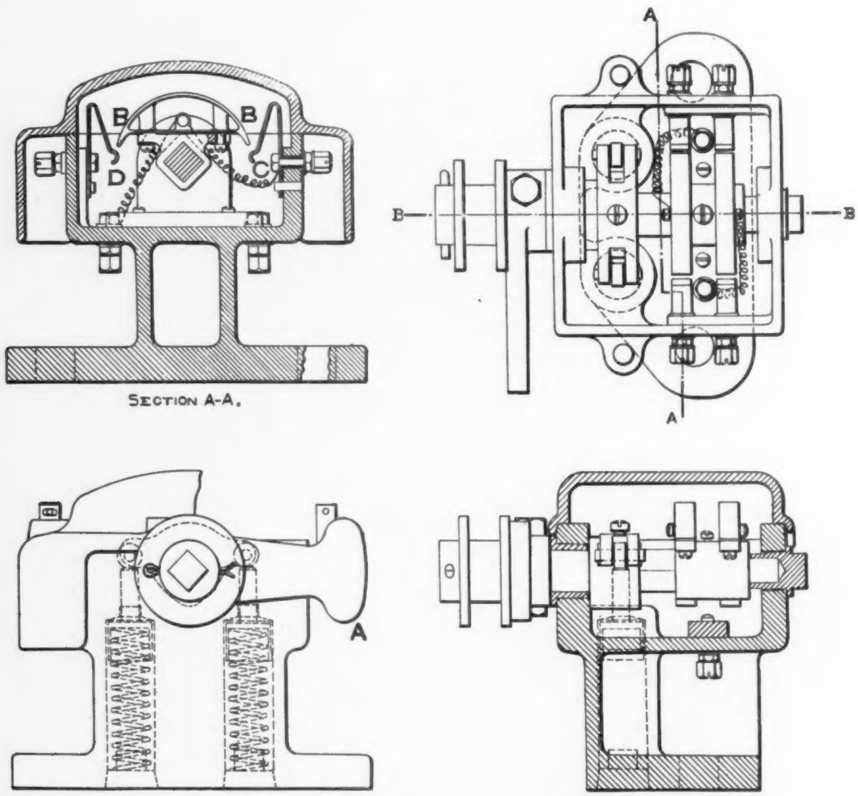


FIG. 4.

SECTION B-B.

walking beam, thereby causing the lowering of the bell attached to the other end of the beam. The bell is raised to the closed position after the air is exhausted from the cylinder by the force of gravity acting on the counter-weights attached to the beam on the same end as the piston.

Figure 3 shows the arrangement of wiring, contacts, valve operating mechanism, indicating device, batteries, etc.

Figure 4 shows the circuit controller in detail.

Figure 5 shows the detail of electro-magnets, pin valve, piston and slide valves.

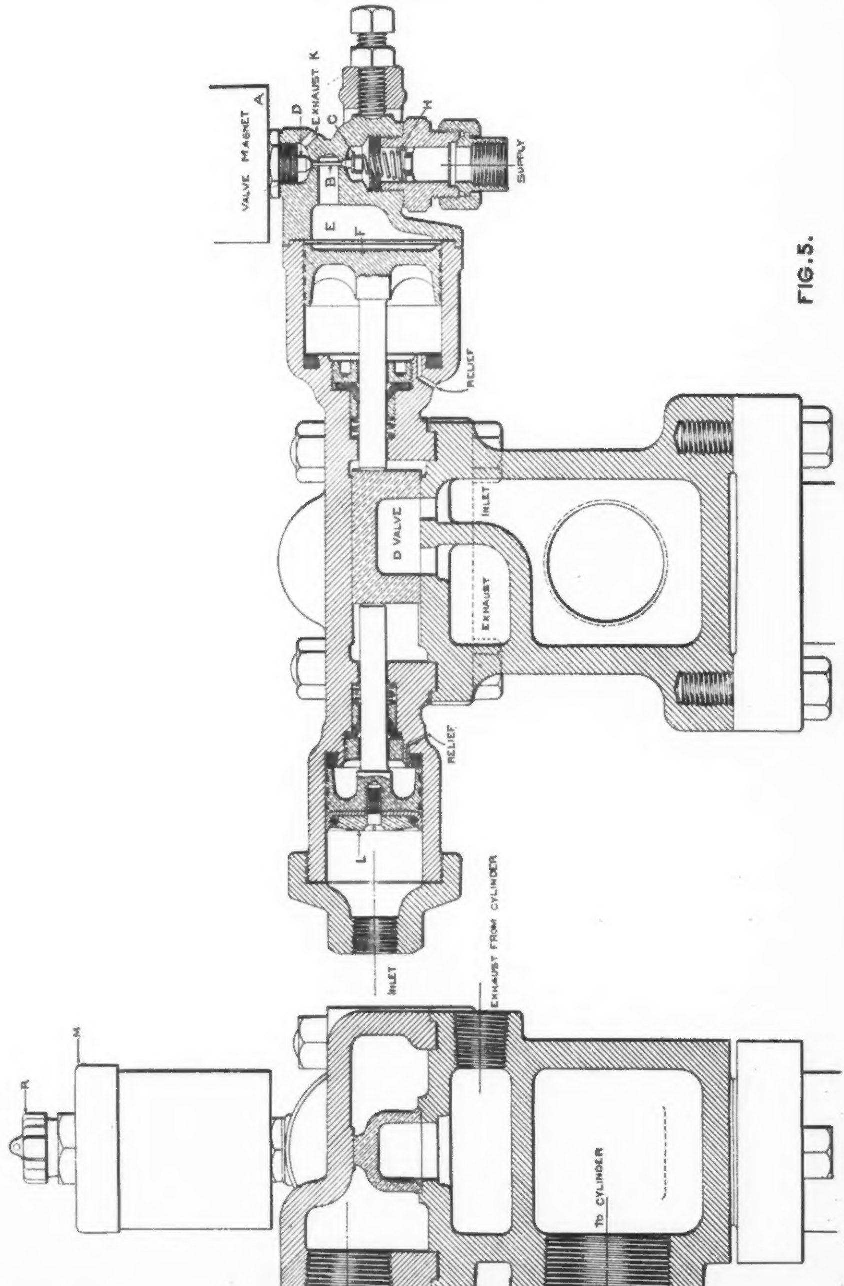

VALVE MAGNET
A
D
EXHAUST K
C
B
H
SUPPLY
E
F
RELIEF
D VALVE
INLET
EXHAUST
RELIEF
L
INLET
EXHAUST FROM CYLINDER
M
R
TO CYLINDER
SUPPLY

FIG.5.

N is the circuit controller; it is entirely protected from the weather; it is shown in detail in Figure 4.

When the bell is down the circuit controller opens the circuit as shown at *a* and *b*, Figure 3, and also opens or closes indicating circuit as shown at *C* and *D*.

P are two arms attached to guide *M* that operate the shaft of circuit controller by making contact with arm *O* when the bell is lowered or raised.

Guide *M* is attached to the same beam as the piston of operating cylinder, and in line with the piston.

Figure 2 shows the push button and indicating apparatus. This can be placed at any distance from the top of the furnace, as the only connection is electrical, and that by means of a seven-wire cable placed in iron conduit. The bells are lowered or raised by pressing the desired button shown at the lower part of the instrument.

At the upper part of the indicating device are two glass windows, through which may be seen the indicating card *A*, Figure 2. The central part of this indicating card is red, and shows red when the bell is traversing from one extreme to the other. The upper part of the card is marked "down" and the lower part "up," thus showing through the small windows when the bell is in either of these positions.

The electro-magnets *B* and *C* control the movements of indicator card *A* through the medium of armature *D*, which is attracted toward *B* or *C*, as the case may be, when the circuit is closed or opened through circuit controller *N* as shown in Figure 1.

The electrical connections are shown at Figure 3.

As seen in Figure 3 the bell *A* cannot be lowered unless bell *B* is up in place, contact at *b* made, and a complete circuit established through electro-magnet *E*. The same is true of bell *B;* it cannot be lowered unless bell *A* is up in place, and the circuit completed through contact *a* and operating electro-magnet *F*.

Figure 4 is self-explanatory, the circuit being open when arm *A* is horizontal, and closed when arm has partly revolved above or below the horizontal position, thereby making contact at points *B* and *C* or *B* and *D*, whichever is desired.

Figure 5 shows the electro-magnet operating valve. The closing of the circuit through electro-magnet *A* lowers the pin valve *B*, opens the valve at *C*, and closes the valve *D*, thereby allowing air to fill the space *E* and move piston *F* to the left, causing the movement of the *D* valve to the left, and opening inlet port, allowing air to enter the operating cylinder that hoists the bell.

The breaking of the circuit demagnetizes electro-magnet *A*, and allows the pin valve *B* to rise, due to the pressure of the spring *H* at the bottom; this closes valve *C* and opens valve *D*, allowing the air to escape from space *E* through valve *D* and exhaust opening *K*. The pressure being removed from piston *F*, the *D* valve is at once moved to the right by means of piston *L*, which is at all times connected with the air supply; this allows the air to exhaust from the operating cylinders through the *D* valve and exhaust port, thereby hoisting the bell. If at any time the bell should not be completely hoisted, owing to the hopper not being entirely empty, the indicating device will show red, and the other bell cannot be lowered until the hopper is empty or the obstruction removed.

Should necessity demand it, a mechanical device operated from the top of the furnace is provided for hoisting or lowering either bell singly or together. This is done by removing cover *M* or plug *R*, Figure 5, from the electro-magnet and pressing down on pin valve *D*, Figure 5.

There is a great saving of air in this device over the old way of having an air valve at the bottom of the furnace at the end of a long air-pipe, for the pipe and the cylinder had to be filled with air at each operation. The apparatus here described moves the bell very quickly and with little jar.

The time required to lower or raise the bell of a large furnace is about ten or twelve seconds. The power required is insignificant, being but nine watts, or about .00121 H. P.

Current is furnished by four small storage cells, two being used while two are being charged or held in reserve. One set of two cells will operate the apparatus for forty-eight hours.

The battery is charged from any source of direct current; in this instance it is supplied from 220 volt direct current mains through three two ampere resistance lamps in series.

Owing to the small current consumed, a gravity or other form of primary battery can be used.

L. H. Thullen.

The Hydraulic Installation at the Panuco Mines in Mexico.*

The gold and silver mining properties of the Compania Minera de Panuco are situated on the western slope of the Sierra-Madre Mountains, about 70 miles inland from the port of Mazatlan. Their mill is almost centrally situated amongst the various mines, several of the winding shafts being close to the mill, probably within 400 meters.

In exceptionally dry seasons the whole of the milling and mining machinery is run by water power, assisted at times by steam power; in average seasons, however, the whole plant is run by water power alone.

The water-power system comprises two reservoirs of different altitudes above the power station, which are respectively termed the high level and the low level dams or reservoirs.

The high-level reservoir comprises a dam of about 9,500 cubic meters of masonry, with a mean height of about 12 meters and a maximum height of 20 meters above the bed of the reservoir, which forms a natural watershed of about 800,000 cubic meter capacity, with an approximate maximum vertical height of 2,250 feet above the turbine nozzles. The reservoir is tapped a little distance from the masonry dam by a steel pipe line of varying diameter, from 16 inches downwards. This pipe line, which is about 8 kilometers in length, is laid above ground, the underside of the pipe being about 12 inches above the ground. It is supported by the flanges resting loosely on cast-iron plates, which in turn rest on a block of stone sunk not more than 6 inches into the ground. This tube line conveys the vertical head of water of 2,250 feet direct to the high-level turbines.

The low-level reservoir consists of a masonry dam of about 2,200 cubic meters of masonry work between two cliffs, that form the sides of a small mountain creek, by which means a reservoir is formed of about 200,000 cubic meters capacity. From one side of the dam the water is tapped by an 18-inch steel pipe line, which conveys a vertical head of water of 240 feet for a distance of about 3 kilometers, to the power station.

The water-power plant above ground comprises six Pelton wheels, so arranged as to drive the entire milling plant and machinery, either by the high-level supply alone or the low-level supply alone, or the two running together. All the turbines are belted direct, where possible, on to the main countershafts of the various departments of the mill and engineering shops, and to air-compressors, for the distribution of energy to the distant parts of the premises, not exceeding 2 kilometers. Electrical energy is only being used for lighting purposes.

In unusually dry seasons the turbine nozzles are changed to a smaller size, sufficient to run about 75 per cent. of the whole machinery, while the remaining 25 per cent. is run by steam power.

The spent water from all turbines is collected in a small reservoir, and is conducted by means of a steel pipe line, 18 inches diameter, down the shaft of one of the mines near the power house, on to a Pelton wheel driving a pair of horizontal air compressors, situated at a depth of about 130 meters below the water level in the above-ground power house reservoir; these compressors, 24 by 24 inches, being belted from the turbine to run at 120 revolutions per minute.

A tunnel about 600 meters in length, with a slight fall from the turbine well, carries off the spent waters from the turbine to the outside of the mine (see illustration). This tunnel is driven mainly for this purpose, but at the same time it drains the upper workings, and also cuts off 130 meters head of water, pumped from the lower workings; it also aids in the ventilation of the mines, and serves as a prospect drive, several payable veins being encountered. In this position the compressors are centrally situated for the distribution of compressed air to the various winding and hauling engines, pump and rock drills in the mine.

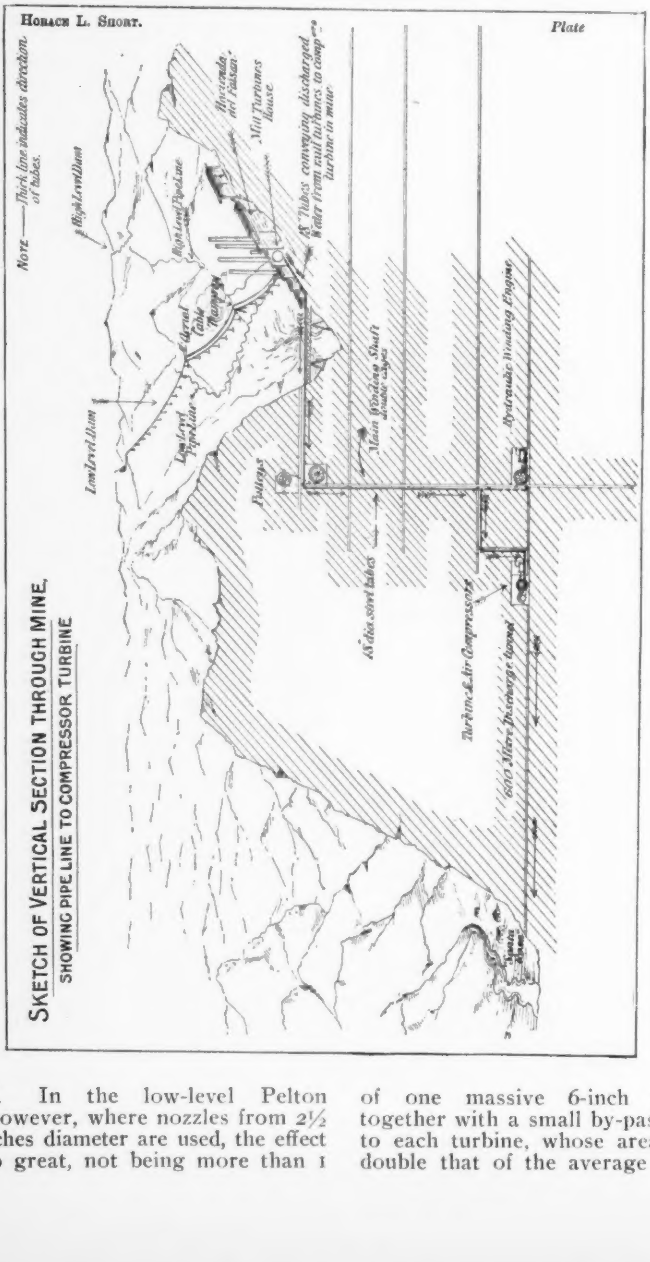
It may be of interest to mention a few small details which materially add to the successful running of the installations.

By using buckets with the dividing edge and lower lip filed to a knife edge, and the water surface of the bucket truly filed and polished, the brake horse power is increased fully 10 per cent. over that

*Abstract of a paper by Horace L. Short, read before Institution of Mining and Metallurgy, London, as published in the *Engineering and Mining Journal*.

obtained with buckets not filed and polished; this refers to the high-level turbines, where the greatest diameter of nozzle used does not exceed ⅞ inch to 2 per cent. according to size of nozzle used.

The starting and stopping valves, which were close to the turbines, consist



HYDRAULIC INSTALLATION AT PANUCO, MEXICO.

diameter. In the low-level Pelton wheels, however, where nozzles from 2½ to 3½ inches diameter are used, the effect is not so great, not being more than 1 of one massive 6-inch gate valve, together with a small by-pass gate valve to each turbine, whose area was about double that of the average nozzle used

with the turbines. This by-pass is, of course, to relieve the main valve from the excessive one-sided pressure, so that it may be opened without undue exertion, and without running the risk of scoring or damaging the valve face.

The pipe line is fitted with several specially constructed spring relief valves; these are mainly for the purpose of relieving the almost instantaneous rise of the pressure, and consequent shock that arises, owing to the ram action that takes place when the water issuing from the nozzles is suddenly arrested either entirely or partly. On several occasions accidents of this class have happened, but they were chiefly caused by unlooked-for intruders; on one occasion the nozzle was found blocked by a small fresh-water fish; on another occasion by a fresh-water lobster, and a large eel, although every precaution was taken to guard against such intruders.

Refuse oil and "swarf" from the milling and mining machinery is found to form a very good protective surface against oxidization, when smeared over the exterior surfaces of the air and water pipes inside the mine; this treatment gives much better results than either tar or paint.

All belt pulleys in connection with both the milling and mining machinery throughout are of unusually large diameter, and all belts are run at an unusually high speed. The following is an instance in point: A 12-inch wide six-ply canvas-rubber belt running at the unusual speed of 7,500 feet per minute, over pulleys 36 inches and 120 inches diameter, respectively. This was examined after running continuously at this speed night and day for two years, and was found to be practically in as good condition as when first put on; and an 18-inch wide six-ply belt running at 5,000 feet per minute, under similar conditions to the above, gave equally satisfactory results. In all cases diagonally riveted joints in the belts were found to be preferable and more reliable than laced joints.

All pulleys from 36 inches diameter upwards are built with hardwood belt faces, wrought-iron spokes (disks in the smaller sizes), and cast-iron bosses. The chief advantages of these pulleys are that they can be quickly and cheaply built; are very light and strong; and that a carpenter can turn the belt face of a 10-foot diameter by 24-inch face belt pulley in its working position, in two hours. If the shaft runs a little eccentrically, the belt face runs perfectly truly, which would not be the case if the pulley had been turned up in the table. Again it is often found that large, broad belts stretch more on one side than the other, with the result that the belt tends to run off the pulley; the remedy for this is to turn the crown a little nearer to one side of the pulley than the other. With a wood rim pulley this can be done while the belt is running, no stoppage being necessary; in fact, the operation can be performed in a few minutes, whilst with the iron pulley it is sometimes a very serious and difficult matter. If the belt face of the pulley is made properly, and of hard and well-seasoned wood, the face will last for six or eight years, and it is only a question of an hour, perhaps, to skim up the face again, and the pulley will be as new.

In the belt-driven air compressors (24 by 24 inches), which are of American manufacture, great trouble was at first experienced with the flywheel driving belts, and it was impossible to run the compressors up to more than 40 pounds to the square inch air pressure, owing to the excessive vertical flapping of the belts, which were very soon destroyed. This, of course, was due to insufficient mass in the flywheel rim, which was increased 50 per cent. by the addition of cast-iron segments, bolted on to the underside of the rim; this addition enabled a pressure of 75 to 80 pounds per square inch to be attained, without undue injury to the belts, and no trouble was afterwards experienced from this cause. These air compressors have a water cooling jacket round the cylinder and cylinder covers, and indicator diagrams were frequently taken to ascertain the efficiency of the water cooling system. From the diagrams taken with and without the cooling water in operation, a difference of from 5 to 7 per cent. was shown in favor of the cooling system, the air pressures being 45 and 75 pounds per square inch receiver pressure.

All air and water pipe flanges are made extra heavy and of special form, to employ the least possible number of bolts. Generally two bolts are used in pipes up

to 4 inches diameter, and three in the larger sizes.

All air mains are of light steel tube from 10 inches diameter downwards. The oil that escapes by the oil collectors near the air cylinders is carried, by the compressed air, along the air pipes and the greater part is deposited on the inner surface of the pipe line; therefore, although this oil is lost at the collectors, it serves to prevent oxidization of the inner surface of the pipes, and serves the two-fold purpose of enabling a thin tube line to be used, and of preventing rust from being carried along by the air in the pipes to the various engine cylinders, which, of course, would be highly detrimental to the inner surface of the cylinders, valves, etc. It was found that the oil collected from the compressor cylinders (heavy cylinder oil) could be advantageously used over again three times, each time being thoroughly strained before using. It should not be mixed with new oil, but used by itself, and fed into the cylinder with a sight feed lubricator.

Thin sheet asbestos near, and brown paper at a distance from, the compressor cylinders, was used for making all air pipe flange joints, the ordinary rubber packing, besides being more expensive than the above, being entirely unsuited for the purpose, as the oil, carried along the pipes by the air, rapidly decomposes the rubber; innumerable and constant leakages result, and frequent stoppages are necessary in order to replace the packing.

The following system was adopted in a flywheel pumping engine, running on compressed air, used expansively in a 10 by 20-inch cylinder, with expansion valve. A super-heated jet of steam is admitted at either end of the cylinder during the admission of air, through fine perforations directly opposite to the air admission ports; the steam is generated in a small vertical boiler close to the engine, the steam pressure being a little above the air pressure, and both air and steam can be cut off independently of each other at any part of the stroke. Many tests went to show that the system was very economical and well worth adopting. To use air expansively, it is absolutely necessary either to heat the air sufficiently to prevent freezing up the exhaust port, or some means must be adopted to prevent the exhaust port being stopped up with ice; otherwise excessive back pressure has to be overcome by the piston. Heating the air is the simplest and best method of overcoming this difficulty, as it not only clears away the ice, but it also conduces to economy. The above system can easily be applied to existing engines at small cost, and will soon pay for itself several times over. The reason that the electrical transmission system was not adopted in any of the above installations, was chiefly due to the fact that in the milling and engineering department the conditions were such as to allow the turbines to be belted directly to all the main countershafts; secondly, as a large number of rock drills are used in the mines, and as, up to the time of the commencement of the installations, no satisfactory electric rock-drilling system was upon the market, it was deemed advisable to use compressed air for this purpose, as its use also enables the rock drill to be used in headings where there is poor ventilation and oppressive temperature. The exhaust air from the drills not only materially aids in the ventilation, but also considerably lowers the temperature of the surrounding air in the immediate vicinity, thereby enabling the operators to perform their work under better conditions than would be the case if an electric rock drill were used.

In the machine shops many pneumatic tools are in use; the steam hammers in the smiths' shops are run by compressed air in place of steam; the largest hoisting plant is run direct by a water-power motor, and the general existing circumstances seem to point in favor of compressed air being used for general underground purposes; and this, after the fullest consideration, has been finally adopted, and the general results obtained after its installation fully justify its adoption.

The total available power of the above-ground turbines together, is between 750 and 800 horse-power for three months in the year, while an average output of about 400 horse-power can be obtained by judiciously manipulating the high and low level water supplies throughout the year, the requirements of the mill and engineers' shops being about 450 horse-power.

The underground power capacity is

about 250 horse-power, which, in the wet season, can be raised to 350 horse-power, if desired.

The whole plant has given entire satisfaction, and has enabled the company to open up additional low-grade veins, which they can now work at a profit.

In case the metal in the mines should give out, the plant can be very cheaply turned into an electrical power station, for the transmission of energy to the various other mining properties which surround the mines of this company.

Compressed Air in the Elevation of Tailings.*

A good deal of experimental work has been done from time to time on the application of compressed air to the elevation of wet pulp. On account of the flat nature of most of our mill sites, elevation of the pulp has to be provided for, and the various methods in vogue show considerable loss of time in the replacing of wearing parts. During the last two years the writer has carried out a great many experiments with a view of devising an elevator that will give continuous work with a minimum of wear.

The results do not show a high efficiency for the power employed, but the lift is continuous in operation, very cheaply installed, and possesses no wearing parts. The lift was tried working in a bore hole of 8 inches diameter, but in many cases it is more convenient to sink a small well for the purpose. The result to date showed that the most efficiency was obtained when the depth of the well was not less than the height of the lift required. The pressure of air required in pounds per square inch was (approximately) half the number of feet to be lifted. In the majority of cases the lift required varied between 20 feet and 50 feet, and the air pressure required between 10 pounds and 25 pounds per square inch.

In most existing installations the air compressors in use were delivering air to the receivers at about four times that pressure, and when air so compressed was expanded to perform its work at a reduced pressure, it was apparent that the power exerted in originally compressing the air above the working pressure required at the lift was absolutely lost.

Thus, at the Mount Malcolm mines it was found that the lift only gave an efficiency of 35 per cent. of the compressor, under the following conditions:

Height of lift above surface of well	52 ft.
Depth of well	54 ft.
Air pressure at receiver per square inch	58 lb.
Reduced air pressure at lift	27 lb.

The air was conducted from the receiver through a reducing valve to the lift. The rising main was a 4-inch black pipe, and the air inlet through 1-inch pipe. This elevator was capable of lifting 100 tons tailings in 24 hours. The most wear was shown on the top bend, which had a life of about six months; in the rest of the pipe the wear was normal.

In this instance, had the air been taken direct from the compressor at the working pressure of 27 pounds, the lift would have shown a much higher efficiency.

It became apparent that to work this system with economy, an independent compressor, designed expressly for giving large quantities of air at low pressure, must be employed. The writer subsequently installed two such—one at the Guests Gold Mine, Mount Morgan, and a similar one at the Lancefield Gold Mine, Laverton. In both cases small compressors were geared on to the line shaft, and they delivered their air without any receiver, direct to the foot of the lift. Under such conditions the only back pressure on the compressor was the weight of a column of water equal to the submerged part of the lift and the rising or falling of the level of the surface of the well was a perfect governor to the compressor. Unfortunately it has been found impracticable up to the present to calculate the efficiency returned by the lift under these conditions, on account of the difficulty in arriving at the actual horse power used by the compressor; but in both cases these lifts are regarded as eminently satisfactory by the managers.

It appeared to the writer that under the last-named conditions the efficiency of this lift was much greater than had hitherto been estimated. The following data, however, taken from observations at the Guests Gold Mine, do not show a high efficiency. This was probably due

*Paper by J. W. Archibald, in Transactions of Australasian Institute, M. E.

to the fact that the compressor was a very crude one, and that being above the capacity required, the back pressure of air may have averaged less than the figures taken. At this mill, of 20 stamps, there is 11.25 cubic feet of pulp, containing 93 pounds sand, delivered per minute. This was elevated 28 feet, equal to a lift of 21,000 pounds 1 foot per minute. Theoretically this would require 11.25 cubic feet of air, at a pressure of one atmosphere (or 22.5 cubic feet atmosphere) delivered to the lift per minute, and this would work out at the equivalent of one horse power. But as the capacity of the lift was considerably greater than was required, the suface of the pulp was generally about 4 feet below the top of the well, and the lift air gauge showed a pressure of from 9 pounds to 11 pounds. This lift has a 4-inch column air inlet through 1-inch pipe; depth of well, 28 feet; height of lift, 27 feet. The compressor took 50 cubic feet of atmosphere per minute, which, at 11 pounds pressure per square inch, was (approximately) 32 cubic feet, and as that was brought from the air compressor cylinder directly into contact with the cold pulp, there would be a considerable loss due to the lower temperature. This had not been accurately determined, but he estimated it at about 14 per cent. (on the basis of 18 per cent. of one atmosphere), and, making allowance for that, they would have 29.7 cubic feet of air at the temperature of the pulp. Therefore, the volume of compressed air in the rising main would be at 2.64 to 1 of pulp—an average compression of 6 pounds of air. At 11 pounds pressure the average load against the compressor piston was 8.914 pounds per square inch, which would work out in the compressor employed at 2.165 horse-power. This was employed to lift (approximately) 21,000 pounds 1 foot per minute, showing an efficiency of only 32 per cent. of the power required for the compressor.

The principal points in favor of this system are:

1. Cheapness of installation.
2. Absence of wearing parts.
3. Uniform continuity of operation.

The cost of installation involves the sinking of a well or bore hole to the depth required to be lifted, and an ordinary pipe of the size required from the bottom of the well to the delivery point, and an air pipe from the compressor to the bottom of the delivery pipe. When the rising column was of a size proportionate to the volume required to be lifted, there was very little sign of wear on the pipes, except on the top bend, which wore out on top in about six months.

Regarding uniformity of operation, when the installation was once made, there was no chance for anything to go wrong. Pieces of stone, which might be washed into the well through the breaking of screens, were carried up through the pipe without difficulty.

At both the mines mentioned there had been no stoppage during the last nine months from any cause due to the faulty working of the elevator. At the Guests mine the pipe was vertical to the required height, and thence horizontal over a series of vats; but the rising column may also be taken in a sloping direction.

As the efficiency of all compressors decreases in proportion to the pressure required, it is evident that the pneumatic elevators will give greatest efficiency where the lift required is not very high. In cases where the lift required is not excessive, the cheapness of installation, coupled with the unfailing continuity of operation, may be found to be strong recommendations for employing this form of elevator.

German Tests of Coal Machines.

While the European mining engineers have not been so quick to take advantage of the recent inventions in coal-cutting machinery, yet they are deeply interested in the subject, and the most enterprising of them have been using various types of coal-cutting machines for some time.

As in America, there are tests which invariably result in proving the advantage of machine methods in coal mining. Such a test is described in a recent issue of *Glückauf*, a German mining journal, which account was translated and appeared in the *Colliery Guardian*, published in London, and is given in substance in this article.

A previous experience with coal-cutting machines, according to this German

authority, has demonstrated their advantages and the special utility of the percussion machines for working under difficult conditions of bedding. It is a well established fact that the use of these machines results, as a rule, in a considerable diminution of the cost of labor per ton of coal, and an increase in the percentage of large coal and therefore an improved selling value, to which must be added the possibility of taking out seams that were hitherto classed as unworkable. If, notwithstanding these advantages, the employment of machines on a large scale is still confined to relatively few mines, the reason for this is mainly to be sought in the poor results that have been obtained in certain pits in consequence of the defective training of the men, ignorance in connection with the installation and working of the machines, and the selection of unsuitable forms of cutting bits.

The chief object of the experiments was to ascertain the air consumption and amount of time required by the different machines (new and old) under conditions as near the normal as possible, a secondary object being to compare the efficiency of various cutting bits, and to deduce from the results conclusions as to the laws underlying the use of coal-cutting machines in general.

The experiments themselves were performed in the four bottom roads of two seams of bituminous coal, 22 inches and 36 inches thick respectively, of normal solidity, the upper seam containing a 2 inch parting of shale. The machines were under the charge of a skilled operator and two helpers. The necessary compressed air was drawn from an ingot-iron boiler, with a capacity of 307 cubic feet, set up close to the working place, and connected with the compressed air main. This boiler was also fitted with a spring pressure gauge, and work was continued until the pressure had fallen from 4-4½ atmospheres to 2·8-3 atmospheres. The volume of air consumed was determined according to the following formula: With a given initial pressure, a, the volume of air in the boiler is $(a+l)$ times the cubical capacity of that vessel; and when the pressure has finally receded to b atmospheres the volume is $(b+l)$ times the capacity of the boiler. Hence the volume of expanded air consumed is $(a+l)$ J—$(b+l)$ J=$(a+b)$ J. All that was necessary, therefore, was to determine the difference of pressure at the commencement and end of the test, and multiply this difference by the capacity of the boiler.

The results showed a comparatively low consumption of air in all the machines. Even the apparently considerable differences consequent on the varying dimensions, age of machine and kind of cutter, are almost destitute of importance when referred to the pecuniary outlay involved. With a good compressing plant, 1 cubic meter of compressed air at 4 atmospheres pressure cost ⅛d. to ¼d., or 3-16d. on the average, and the consumption of air in undercutting 1 square meter of coal to the average depth of 68 inches ranges between 25 and 43 meters. Since these figures correspond with 5 and 8·6 cubic meters of air under 4 atmospheres pressure, the cost of the air varies between 1d. and 1½d. per square meter, a practically immaterial difference. Greater importance attaches to the difference in time consumed, the quickest, for a depth of 68 inches being twenty-one minutes, and the slowest thirty-four minutes, which, at the rate of 1·6 shillings per shift for the two men, makes a difference of 4d. in the cost, or six times the difference due to the varying consumption of air.

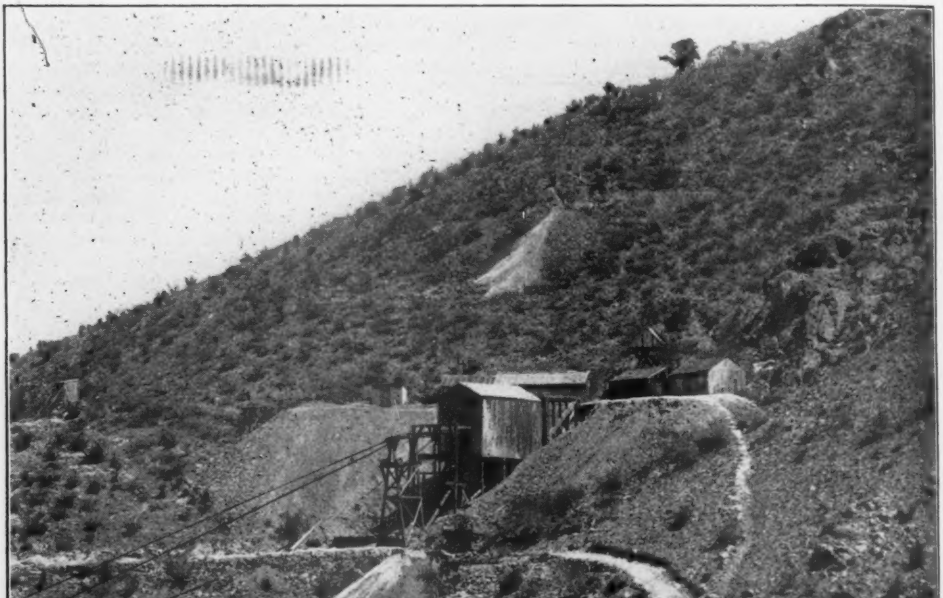
Following the English text the conclusion to be drawn from this is that the volume of air consumed may generally be disregarded, attention being concentrated on the rapidity of working, and a sufficiently strong construction of the machine to minimize the risk of loss of time through breakdowns. These conclusions were also confirmed by numerous experiments, wherein the stoppages caused by defective construction or other sources of hindrance led to loss of time and money, and which, on account of their imperfect results, are not recorded in the table. In any case it cannot be ignored that small and light machines that can be worked by one man are advantageous, although the advantage is confined to the saving of time effected in setting the machine up and dismounting, and would disappear in working places when more than one man is employed at a time. Light weight is also of some importance in the case of steep

seams. The average time consumed in making the various cuts was as follows: 20 inches, 19.7 minutes; 40 inches, 22.2 minutes; 60 inches, 25 minutes; 68 inches, 27 minutes; and 80 inches, 30 minutes per square meter undercut, and indicates the advisability of making broad cuts of segmental shape.

Machinery in New Mexico Silver Mines.

Introduction of modern methods in mining machinery is bringing a number of silver mines in New Mexico into a highly profitable state. Where extreme difficulties were met with in making these mines pay under the old method, the present few years have seen some important changes. Among the most noteworthy are at Modoc Mine, in the County of Donanna, New Mexico.

This mine has been equipped with air drilling and hoisting machinery and a new working shaft sunk which greatly facilitates the removal of the ore. The power plant of the mines and the concentration mill contains two 60 H. P. tubular boilers, one 50 H. P. slide valve steam engine, which supplies the power to the mill; a 10 H. P. slide valve steam engine operating a dynamo for electric lights, and a 16 x 18 inch Leyner steam actuated straight line air compressor. The air compressor furnishes air for eight New Water-Leyner drills and two hoists in the mine, and also, when required, furnishes air for cleaning screens, etc., in the mill. The air is transmitted to the mine by a 4-inch pipe at very little loss. In the concentration mill pneumatic concentrators are used.

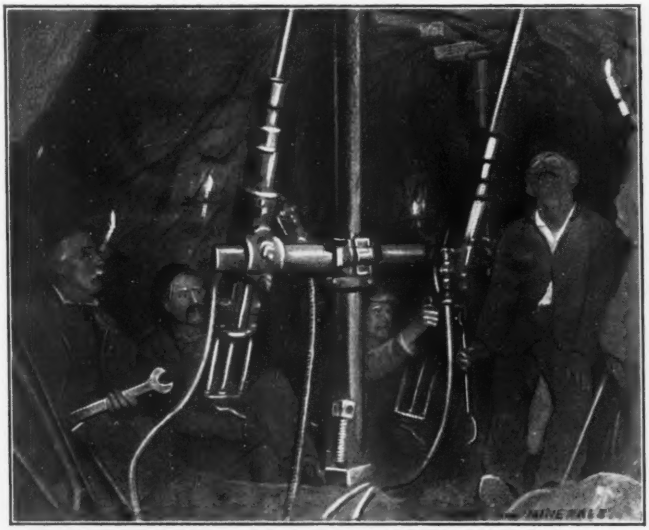


MODOC MINE, SHOWING UPPER TERMINAL OF TRAMWAY.

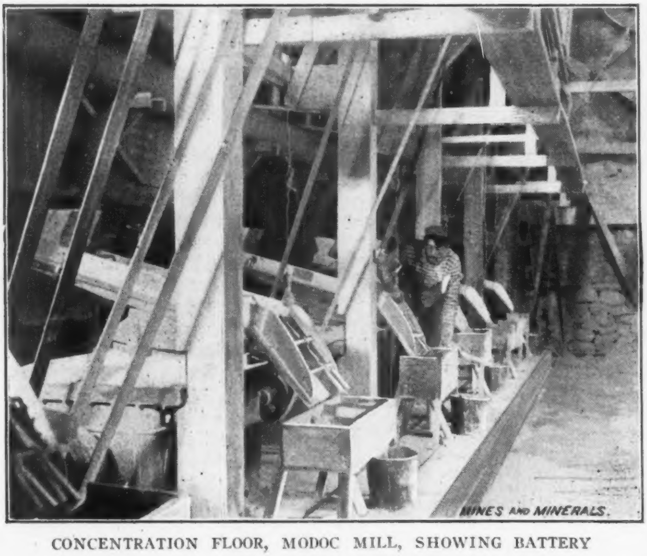
The results of the use of dry concentrators are being awaited with much interest by the mining men of that section, as many valuable properties have

remained idle for years simply for lack of water or other means for cencentration purposes.

The illustrations used for this article were obtained through the courtesy of *Mines and Minerals*, which recently published an exhaustive description of the mines in the Organ mining district.



WATER-LEYNER AIR DRILLS MOUNTED ON COLUMN WORKING IN STOPE, AT MODOC MINE.



CONCENTRATION FLOOR, MODOC MILL, SHOWING BATTERY OF HOOPER PNEUMATIC CONCENTRATORS.

Economical Repairs to Air Pumps.*

In order to give what we considered the best practice for repairs to the 9½-inch air pump an accurate account of both labor and material was kept to ascertain definitely the most economical way of doing the work creditably, and we have found that the following is the best.

The practice of partially overhauling pumps on engines should only be indulged in to a very limited and unavoidable extent. It has been found a much more economical and reliable practice to remove the pump from the engine and give it a thorough overhauling in the air-brake repair room, than to attempt to repair it on the engine in the round house

We have adopted the plan of overhauling air pumps at our general shop. This eliminates improper repairs being made at the smaller, outlying places, and the carrying of extra stock at those points for making repairs, which is one of the greatest expenses attached to a railroad company. It can be readily seen that the repairs to air pumps will be much more satisfactory and economical when done at a general, centralized point, and under the direct supervision of a competent and thorough air-brake man. There are two very important factors we must bear in mind; first, "Workmanship"; second, "Standards." Only such men who have proved themselves competent and who have been thoroughly instructed by the general air-brake inspector, should be employed on repairs to air pumps. Standard sizes and parts should be adhered to as much as possible.

Air pumps should first be put into a vat or tank containing a strong solution of lye, and allowed to soak until all grease and dirt have been removed. Steam should not be admitted direct into the vat, as with this method the solution is rapidly diluted. A coil with a drain should be used. The pump should be removed from the vat and thoroughly blown out with steam until all ports and passages are perfectly clear. This work should be done by a helper. The pump should then be turned over to the air-pump repair man, and should be thoroughly dismantled.

The practice of scraping main valve bush No. 75, and applying a new one instead, is an extravagance, to say the least. The main valve bush should be pressed out of the head, put in a lathe, and bored to 3 5-16 of an inch, after which a bushing should be turned to fit the main valve bush that has been bored, and should be forced in, bored to standard size and properly faced, ports to be drilled through the new bushing. The bush is now ready to be pressed back into the head. This work can be done for 85 cents, and against $4.75 for a new bush is a saving of $3.90.

The left main valve cylinder head should be placed in a lathe and bored to 2 3-8 of an inch, after which a bushing should be turned and pressed into the head, bored and faced to standard size, and ports properly drilled. This work can be done for 40 cents, and against 75 cents for a new head, is a saving of 35 cents.

The large and small main valve piston packing rings Nos. 78 and 80, should be removed and new ones applied and properly fitted. Our experience has been that home-made rings do not give the proper wear and life that rings furnished by the Westinghouse Air-Brake Company do. The main slide valve and its seat should be properly faced. When the main slide valve has 3-64 of an inch play between shoulders of the main valve stem, it should be scraped and a new valve applied.

Next remove the reversing valve chamber bush No. 73, and apply a new one. Also apply a new reversing valve No. 72. We have found that when bush is renewed an old reversing valve should never be applied.

Three-sixty-fourths of an inch play between valve No. 72 and reversing valve rod, when valve is new, calls for a new rod; however, templets should be used to ascertain which part is worn and needs renewing.

It should also be noted that the reversing valve chamber cap is properly fitted on bush No. 73 and on the head proper.

Care should be taken that the distance between the knob on the end of the reversing valve rod and shoulder is of the

*Correspondence by Mr. Otto Best, Air Brake Inspector of the N. C. & St. L. Railroad, at Nashville, Tenn., as published in *Railway and Locomotive Engineering*.

proper length, the reversing valve plate should be removed to ascertain the exact condition of the under side. If worn on either side, apply a new plate.

Steam piston and rod No. 65 should be examined, and it is quite essential that the rod be perfectly true. New piston packing rings should be applied. Great care should be taken in the workmanship in applying rings, otherwise the pump will blow, and back pressure will be materially increased.

When a packing ring is cut, that portion of it nearest the ends has a tendency to remain straight. When the ring is reduced to the size of the cylinder, the result is a poor fit for almost one-third of the circumference. To obviate this trouble, and thereby secure better fitting rings, it is necessary to either file off the outside of the rings nearest the ends, or turn them up in lathe after the rings have been cut. Either plan will do, just so the rings are made to fit the cylinder properly. The same is applicable to the air cylinder piston packing rings.

In applying piston No. 66 it is desirable that lock nuts should be used on the end of the piston rod, as furnished by the Coffin-Megeath Supply Company, Franklin, Pa.

It is the most advisable and most economical way, when necessary to bore steam and air cylinders, to bore them to a standard of 9⅝ of an inch and apply new pistons and rods.

The centerpiece needs more than passing notice. If the piston rod has been turned down in order to true it up, new glands should be applied, and as close a fit on piston rod without binding.

Stuffing box nuts should fit nearly, and the box itself should be carefully examined to see that it is properly secured and tightened in the centerpiece. Air valve seat No. 87 and valve cage No. 88, when worn, should be removed and new ones applied; also new air valve No. 86. Care should be taken that the lift of air valves does not exceed 3-32 of an inch.

It is not advisable nor practicable to use new air valves with old valve cages or valve seats unless seats are properly trued. All copper joints should be annealed.

All repaired pumps should be put on a test rack and run a sufficient length of time to assure their efficiency before being placed in active service.

By following the above recommended practice of repairs, the failure of air pumps on our line of road has been reduced to a minimum. For the year ending June 1, 1903, there were but three air pump failures, which were reported as follows: " Reversing rod broke." " Main piston rod broke," " Reversing plate bolt worked out."

Track Tamping with Air Blast.

When steel ties were laid on a section of track on the Bessemer and Lake Erie Railroad, through Greenville, Pa., two years ago, it was found that tamping with bars or tamping picks could not be effectively performed. To meet the emergency an air block tamping apparatus was arranged, which, it is said, did the work very satisfactorily.

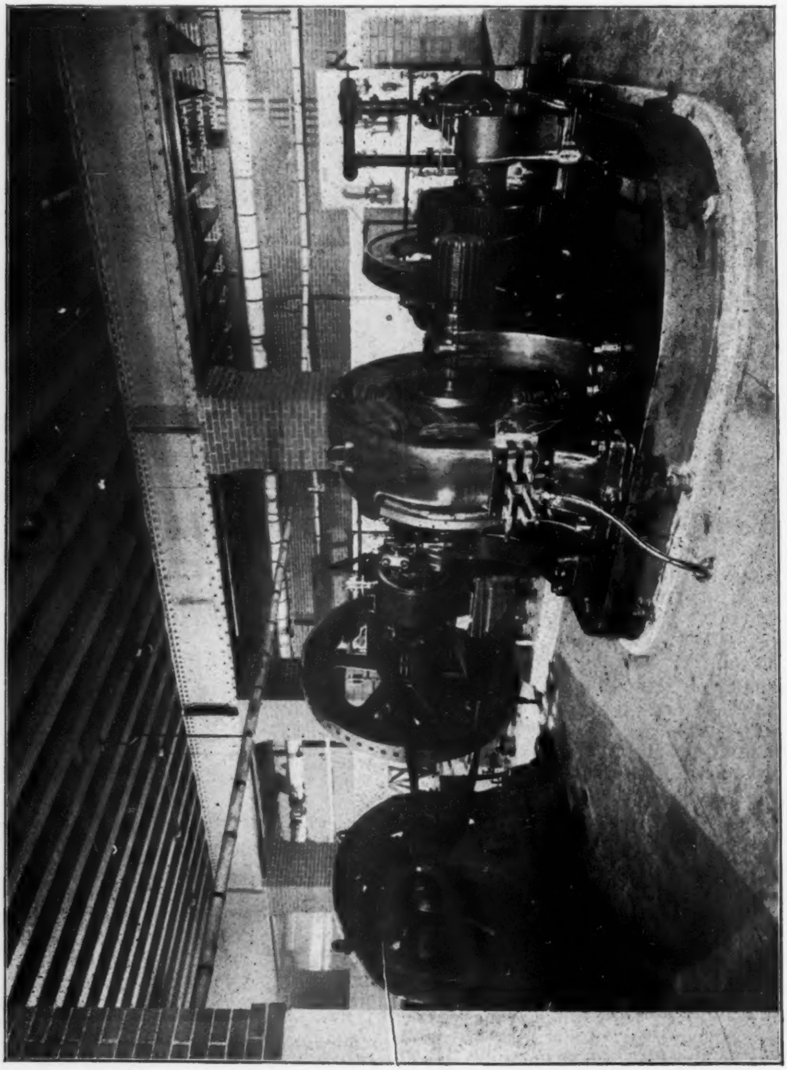
The steel ties used were of the inverted trough section, with flaring sides, about 3½ inches deep. The rail was fastened to the tie by means of bolts and clips, the former being passed through the top table of the tie. The ballast used was broken slag. In surfacing the track the desired end was secured by blowing pulverized slag in the ends of the ties to fill the space caused by lifting the rail to grade.

This track tramping apparatus consisted of a blower clamped to rails, turned by two cranks. The blast thus secured passed through a hose connected with a piece of pipe crooked at the bottom to insert under the ties. The material for ballasting was heaped into a funnel or hopper at the top of this piece of pipe.

The idea of tamping tracks by blowing fine gravel or other material under ties with an air blast is by no means new. Mr. F. R. Coates, now chief engineer of the Chicago Great Western Railway and then road master of the New York division of the New York, New Haven and Hartford Railroad, made some experiments in this direction six years ago. He investigated this idea and was quite encouraged with the results. Subsequently, however, this subject seems to have dropped out of sight until utilized by the Bessemer and Lake Erie Railroad.

Compressor Plant at Terminal Station.

An interesting description of the new passenger terminal station of the Chicago, Rock Island & Pacific, and Lake Shore & Michigan Southern Railroads, on Van Buren and La Salle streets, Chicago, was given in a recent number of the *Western Electrician*, a Chicago publication. Under the title, "Electricity in the New Rock Island-Lake Shore Terminal Station in Chicago," some interesting details concerning the electrical equipment of the



ELECTRICALLY DRIVEN COMPRESSORS AT CHICAGO TERMINAL STATION.

station were described. In the course of the article the following reference was made to the compressor plant:

"Of considerable interest are the electrically-driven air compressors. They were furnished by the Ingersoll-Sergeant Drill Company, and are both of the cross-compound type, one having a capacity of 500 cubic feet per minute and the other 1,000 cubic feet. The air is used for testing air brakes in the yards, pumping water from the deep well into a large tank, from which the other pumps draw their supply, for cleaning cars and also for various purposes around the plant. The compressors are driven, as shown, by two large motors—one of 150 horse-power and the other of 75 horse-power—to which they are connected by the Renold silent-chain drive. It is said that the larger compressor is one of the heaviest applications of this driving system yet made."

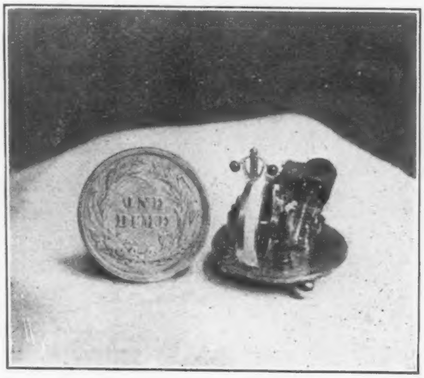
There were several illustrations for this article, one of which was a picture of the electrically-driven compressors, which is reproduced through the courtesy of the *Western Electrician,* on the opposite page.

Smallest Air Engine Ever Built.

To compressed air has come the distinction of operating the smallest engine in the world. This remarkable piece of mechanism was built by Mr. A. G. Root, of Danbury, Conn. It rests on a ten-cent piece, and stands no higher than the same coin on its edge, and yet is so perfect in its construction that a slight air pressure operates it with all the precision of a huge Corliss.

This tiny engine, which will probably be seen at the St. Louis Exposition next summer, was built by Mr. Root without drawings or model, simply making one part and fitting the next one to it. It was all done by hand and occupied his spare time for nearly a year.

To give some idea of the size of this miniature air engine the measurements of the various parts will be of interest. They are given in 64ths, 32ds and 16ths of an inch. No part is ½ inch in any direction. The steam chest is 6-32 by 9-32 of an inch, and the cylinder is 8-32 by 9-32 of an inch, with a stroke of 3-32 of an inch. The main shaft has an extreme length of 5-16 of an inch, and has attached a flywheel 7-16 of an inch in diameter; the largest diameter of the shaft is recorded as 3-64 of an inch. There is a band of gold 7-64 of an inch wide; the crank has a length of 4-16 of an inch; the crank wheel is 6-32 of an inch in diameter. The cylinder, which is sheathed with ebony, has an extreme diameter of 3-16 of an inch and a bore of 5-64 of an inch. A silver feed pipe is 2-32 of an inch in diameter; the valve rod has a diameter of 1-64 of an inch, and that of the piston rod is less than 2-64 of an inch. This tiny mechanism is built of steel, brass, silver and gold, and weighs complete 3 pennyweights.



SMALLEST ENGINE EVER BUILT.

The accompanying illustration shows the exact size of the engine. The engine is horizontal, but if it had been constructed as a vertical one it would have occupied a floor space of 7-16 of an inch. Despite its very small size this air engine operates just as regularly and successfully as the large machines, and has attracted much attention wherever it has been shown.

An Old Type of Compressor.

A type of compressor not often found these days has been in use for some time at the power house of the Albemarle Zinc and Lead Co., Fabers, Nelson county, Va. The only means for cooling the cylinder is a ⅜-inch pipe attached to a ¼-inch opening and injecting directly into the cylinder. This pipe has to be left wide open

or the cylinder becomes very hard. The water injected, of course, goes into the air receiver and every half hour or so has to be blown out. To prevent this water going into the air receiver it was suggested that where two lines connected through a ⅜-inch pipe in place of the pet cocks that are on the end of it in the air cylinder, and were they to be joined to a Mason steam trap, the surplus water would be drawn therein and thus keep the water from the air receiver.

This type of compressor appears to be an application of the old water displacement system. This principle was used quite successfully in the early days and even now finds a place on the continent. It is a reasonably efficient method so far as the action of the compressor is concerned, but it is very defective owing to the limited speed at which the compressor must run. It does not seem likely that a trap connected with the cylinder drips as proposed will give satisfaction. In this place it might be possible to build a marble or wooden tank about the air cylinders and keep it filled with running water, thus doing away with the injection water.

Rock Island Air Brake Instruction Car.

The accompanying engraving was made from a photograph of the Rock Island air brake instruction car No. 2,500. In the lecture and demonstrating room are the air appliances of two locomotives, 13 freight car brakes and one passenger car brake, as well as sectional instruments worked in tandem. The locomotive equipments can be coupled so as to represent a "double-header" freight with coach in rear, "single-header" freight or "one-car" passenger trains. One of the locomotives and coach is for demonstrating the high-speed brake, pressures and reducing valves on brake cylinders. The necessary pressure gauge, tell-tales, slack adjusters, etc., are in proper connection. In addition to these appliances, there are steam and hot water heating systems, electric headlight—engine and dynamo complete—in working order, pneumatic track sanders, vacuum driver brake instruments, injectors, lubricators, pop safety valves cut in section; also colored charts, blackboards, literature, rules, etc., governing their operation and maintenance.

ROCK ISLAND AIR BRAKE INSTRUCTION CAR.

The adjoining room is equipped with boiler, air pump, water pump, tank, injector and coal bunker for supplying steam and air for demonstrating and heating the car, which are connected up in such a manner as to be able to supply "air" and "steam heat" to a full train should the engine fail in these respects with this car en route. The opposite end is the office, library and living room, with usual commodities for the instructor. All is lighted with electric (incandescent and arc), gas and oil lamps. All persons whose duties in any manner bring them in contact with train air appliances are required to attend the lectures and pass a satisfactory examination, when certificates are issued indicating their proficiency. The car is in charge of Mr. W. J. Hartman, air brake expert, who at present is touring the line.—*Railway Age.*

An Air Compressor in the Wilderness.

While the idea of a sectionized air compressor for transportation across lands where railroads are practically unknown is by no means new, there is always more or less interest taken in any of the achievements of progressive manufacturers of compressed air machinery in which many and difficult obstacles are overcome.

It was not long ago Messrs. A. & Z. Daw, of London, Eng., received word of the complete success of such an enterprise in which they were primarily interested. One of their air compressors, which was manufactured by Mr. Robey & Co., Ltd., of Lincoln, Eng., was carried through 110 miles of bush into the wilds of Africa, and after a trip of two months the whole machine was safely delivered at its destination, with no part damaged or missing.

Readers of Compressed Air will find an account of Messrs. Daw's enterprise in *Engineering*, an English publication. Concerning the air compressor and its unusual trip, *Engineering* says:

"The Ashanti Goldfields Corporation, in order to expedite some very important development work at their mines in Ashanti, decided to lay down an air-compressing and rock-drill plant, and applied to Messrs. A. & Z. Daw to meet their requirements. The difficulties of transport in this recent addition to the British Empire—the great natural wealth of which is now being made manifest by British enterprise—are of such a nature, pending the completion of the railway, as at the time to cause great misgivings as to the feasibility of building a machine (subject to such heavy work and strains as an air compressor) in such small sections as to admit of its being taken up country by native carriers. The distance from Cape Coast Castle to the Ashanti Goldfields mines is 110 miles, the pathway to the mine being for the greater distance through a primeval forest. Full particulars of the difficulties of transport were given by the consulting engineer to the Ashanti Goldfields Corporation, who fixed the limits of weights of each section at 80 pounds to 90 pounds, except for the cylinders, crankshaft, and rims of the flywheels, which parts were limited in number, and were not to exceed 250 pounds each in weight. To these limits of weights Messrs. A. & Z. Daw, in conjunction with Messrs. Robey & Co., Ltd., designed and built a compressor.

"The compressor is of direct-acting duplex type, consisting of two 13-inch diameter steam cylinders, and two 12-inch diameter air cylinders, all with 18-inch stroke, carried on a massive wrought-steel foundation plate built up in sections of 90 pounds. The steam and air cylinders were constructed in sections of 250 pounds, the liners being whole; all joints are metallic, and to keep within the limits of weight the steam cylinders have loose steam chests. The 5½-inch diameter crankshaft required special care, and was built up in five sections, varying in weight from 200 pounds to 226 pounds each section, and was so dowelled together as to prevent the possibility of error on its re-erection. The two flywheels are each 7 feet in diameter, and built up in 36 sections. The air cylinders are fitted with Daw patent balanced inlet and delivery valves.

"On completion of this unique air compressor it was exhaustively tested by the consulting engineer of the Ashanti Goldfields Corporation, and although weighing 15½ tons, built up in the remarkably small sections above described, it worked with the greatest smoothness and steadiness. The compressor was designed to run at 133 revo-

lutions, or 400 feet piston speed per minute, and was run for several weeks in the shops at its maximum speed with very satisfactory results.

"The compressor was then dismantled and packed, special care having to be taken in the packing to meet the great difficulties to be contended with in landing goods at Cape Coast Castle and the absence of all roads through the country; and the following particulars of how the landing and transport were effected in getting this first compressor into Ashanti will be of interest.

"Owing to the known difficulties, a special transport officer was sent out from England by the Ashanti Goldfields Corporation in charge of the compressor. The landing was effected by means of surf-boats, which, on grounding on the sand, were turned over on their sides, and the heavy packages rolled up beyond the reach of the seas, the cases, in most instances, being covered by sea water. Previous to the arrival of the vessel, it had been arranged that about 600 carriers should be present to take all the parts of the machine inland, over rivers and through swamps, many of which were dangerous to human life. The corporation also ran the risk of losing important sections (especially when the loads are not cut down to a weight which could be conveniently handled), thereby rendering the machine useless until a renewal could be dispatched from England."

Notes.

Compressed air has already proved dangerous in the hands of practical jokers. The last victim is K. Reaski, a lad employed at the Schenectady works of the American Locomotive Company. It is claimed that his injuries were of a very serious character.

The Mining Reporter declares that the automatic drill sharpener run by steam or compressed air is a machine that marks an advance in that kind of work. Its advantages are in economy and rapidity. Compressed Air has already noted one type of these machines which is now on the market.

Compressed air is now being used by the C. & M. B. Railroad to clean the passenger coaches at its Lancaster, Ohio, shops. An air compressor has been installed there which compresses the air to about 80 pounds. A steady stream of air is used to clean the cushions in the cars, while a sweeping machine is being introduced to take the place of a broom.

The Los Angeles Railway Company is having 80 new cars built to be used in the streets of Los Angeles, Cal. They are operated by electricity and are equipped with Westinghouse air brakes with motor-driven compressors. Among the other cities which have recently ordered similar equipments are Oakland, Cal.; San Francisco, Cal., and South Bend, Ind.

The H. K. Porter Co. has just issued a revised edition of its catalog of "Light Locomotives." It conforms with the usual style of the catalogs of that company, but contains some material which has not been printed heretofore. Considerable space is devoted to pneumatic locomotives and the necessary equipment for operating them in mines and other industrial establishments.

The Colliery Guardian, an English publication, reports that coal-cutting machines are being introduced into the northern fields of New South Wales, compressed air being used in one colliery and electricity in another. The innovation has not been resisted by the miners, although they are reported to be unsettled respecting the altered conditions of labor and the rates of pay.

The patent rights for a hoist operated by compressed air, the invention of Mr. C. H. Peck, of Elmira, N. Y., have been purchased by the Imperial Pneumatic Tool Company, of Athens, Pa. The principal feature of the hoist is a construction which permits it to be used in that class commonly known as tackle or chain hoists, which are used in machinery shops and other structural works.

In an exhaustive description of the boiler shops of the Babcock & Wilcox Company, given recently in the *Engineering Record*, note was made of the general use of pneumatic tools throughout

the shop. The compressed air for these tools is supplied by two Ingersoll-Sergeant Class JC belt-driven air compressors. One of these has air cylinders 14 and 7¼ by 17 inches, and the other 24¼ and 16¼ by 16 inches.

Compressed air and electricity are to be combined to operate a mammoth clock, which, it is reported, will be one of the features of the St. Louis Exposition. The two powers will operate the hands, which are to sweep over the face of a dial 125 feet in diameter, composed of a flower garden with appropriate blooming plants aranged in groups to represent the hours. The Johnson Service Company, of Milwaukee, is supplying the electric and pneumatic apparatus.

Pneumatic tools and other modern appliances for working stone have come to stay, declares *Rock Products*. In this case a number of them will keep coming right along, for these not only lighten and improve the work, but help make it possible to push stone in the places where it would otherwise be barred by the excessive cost. In another note this same paper adds: "This is the time of the year when operators in the quarries look with favor on pneumatic appliances as compared to steam, for it is hot enough without the steam at work."

Among the new catalogs that have made their appearance during the month of July is one issued by the Ingersoll-Sergeant Drill Co., illustrating and describing its rock drills, mining and quarrying machinery. It is known as No. 43. The catalog is handsomely printed and bound and contains much new material as well as a great many new cuts, which not only illustrate the various products, but show the machinery in actual operation. There is some valuable information regarding the construction and use of the drills and other machinery, in addition to a very full description of the different types. Some of the illustrations show important engineering undertakings now in progress in which Ingersoll-Sergeant machinery is figuring.

The efficiency of compressed air in operating pumps under ground in mines is greatly increased by reheating the air at a point near the pumps. When the ventilation is good this is generally easy to do. A compound direct-acting pump, heated sufficiently to prevent freezing will pump double the amount of water with the use of a given amount of air that a single pump will. One suggestion to prevent the freezing of a mine pump is by aranging the drip from a pipe so that a small stream of mine water will flow upon the exhaust opening. This usually keeps the temperature at a point somewhat above freezing. A large exhaust opening is much easier to keep from clogging with ice than is a small one.

The annual meeting of the American Mining Congress will be held at Deadwood and Lead, South Dakota, September 7 to 12. This gathering promises to be one of unusual interest, as it will be held in one of the most famous mining sections of the country. In the last quarter of a century the famous Black Hills of South Dakota are reported to have produced in gold alone $121,000,000. Several excursions have been arranged, one of the most instructive of which will be to the Homestake Company's properties. This company has one of the largest and most complete compressor plants to be found in any of the mines of that district. This plant will undoubtedly be of great interest to the visitors. A description of a compressor recently added to its equipment is given in this issue.

Among the quarries that have recently been equipped with more extensive compressed air power plants are those of the Granite Railway Company, located near West Quincy, Mass. Important improvements to both quarries and cutting yard have only recently been brought to completion. Adjoining the new building in the cutting yard is a brick power house containing boilers, a 150-horse-power engine and a 115-horse-power Ingersoll-Sergeant air compressor which has a capacity of 638 cubic feet of free air per minute. This supplies compressed air for surfacing machines and pneumatic tools, as well as for operating three powerful hoisting engines. Heat will be supplied to the new building in winter by means of a blower operated by an independent engine.

The Ingersoll-Sergeant Drill Company, which has placed a line of pneumatic tools on the market, reports immediate recognition of the superiority of the Haeseler "Axial Valve" hammers. Among the latest purchasers of these tools are: Niles-Bement-Pond Company, Ramapo Iron Works; MacPherson Switch & Frog Company, Creswell & Waters Company, Waren Foundry & Machine Works, Chicago, Rock Island & Pacific R. R., Brown Hoisting & Conveying Machine Company, Howard Iron Works, International Boiler Works Company. The "Axial Valve" mechanism used in the construction of the Haeseler hammers has produced a steady working and unbreakable valve.

Another experiment with the Westinghouse air brake has been made in England, for the purpose of solving the problem of controlling freight trains traveling at high speeds on steep descending grades. The Northeastern Railway Company recently conducted a series of important trials on its lines, which at one point attain an elevation of 1,800 feet above sea level, and is one of the steepest sections of railway in the United Kingdom.

Forty heavy coal cars comprised the train, each car being equipped with Westinghouse rapid-acting brake apparatus, the air pressure being operated from the engine. Despite high speed, unfavorable climatic conditions and traveling on the down grade, the train was brought to a stand in a very short distance, the application of power on both front and rear wheels of the train being practically simultaneous.

The trials were conducted under the supervision of the leading officers of the Northeastern Railway and representatives of the Westinghouse Brake Company, and are said to have been highly satisfactory.

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U.S. PATENTS GRANTED JULY, 1903.

Specially prepared for COMPRESSED AIR.

732,696. PORTABLE PNEUMATIC RAM. Joshua B. Barnes, Springfield, Ill., assignor of one-half to C. A. Thompson, St. Louis, Mo. Filed Jan. 21, 1903. Serial No. 140,019.

A compressed-fluid ram, comprising a cylinder, a tool-holder movably carried at one end thereof, a piston reciprocating within the cylinder, a valve-chamber having inlet and exhaust ports for the motive fluid and having passages leading to opposite ends of the cylinder, a valve controlling said passages, manually-operated means for throwing said valve in one direction to admit the motive fluid in rear of the piston to propel it forward and fluid-pressure-operated means for returning the valve to initial position.

732,789. AIR-BRAKE FOR VEHICLES. Joseph S. Smart, Wait, Mich., assignor of one-half to James Perkins, Wait, Mich. Filed Mar. 14, 1903. Serial No. 147,822.

732,856. DIRECT-ACTING COMPRESSED-AIR BRAKE. Wilhelm K. M. Hildebrand, Gross-Lichterfelde, near Berlin, Germany. Filed June 16, 1902. Serial No. 111,893.

A valve mechanism for direct-acting compressed-air brakes, comprising a valve in the direct passage from brake-pipe to brake-cylinder, only closing at high pressure in the brake-pipe, and a distributing valve connecting the auxiliary air-reservoir with the brake-pipe and with the brake-cylinder, and only opening when said valve closes, all substantially as and for the purposes described.

732,892. COMPRESSED-AIR LOCOMOTIVE HEATER. Wilson R. Pratt, Topeka, Kans. Filed Oct. 15, 1901. Serial No. 78,743.

A compressed-air heater, the combination with a casing of inlet and outlet means for conducting air into and out of said casing, burners mounted in the casing, flues in said casing, hollow protecting-shields mounted in said flues; to receive the flame from the burners of the heater, and apertured supporting means for the shield for holding the same above the burners, said means engaging the flues.

733,223. AIR-FORCING DEVICE FOR VENTILATION OR SIMILAR USES. Jean B. Le Reau, dit L'Heureux, Detroit, Mich., and Joseph Le Reau, dit L'Heureux, Windsor, Canada. Filed July 18, 1902. Serial No. 116,038.

733,315. ELECTROPNEUMATIC VALVE. Frank L. Dodgson, Rochester, N. Y., assignor, by mesne assignments, to Pneumatic Signal Company, Rochester, N. Y., a Corporation of New York. Filed Oct. 25, 1901. Serial No. 79,942.

An electropneumatic valve, an electromagnet having an armature, a double-seated valve, a valve-casing having ports connecting a supply with an outlet through one valve-seat, and closing the exhaust when the armature is in one position, and a port connecting the outlet with the exhaust through the second valve-seat and closing the supply when the armature is in the other position, means for operating said valve by movement of said armature, and means for independently adjusting the distance between the armature and the valve and the distance between the armature and its magnet without disconnecting any parts of the mechanism or disturbing any other adjustments.

733,429. BRAKE-VALVE. Frederick E. Schmitt, New York, N. Y., and Lewis E. Moore, Phœnixville, Pa. Filed Jan. 22, 1903. Serial No. 140,086.

A valve for operating an air-brake system, consisting of a valve-chamber connecting respectively with an air-reservoir and an air-brake cylinder, a valve-plug movable in said chamber, means by which the operator may move said plug so as to open communication through the valve between the air-reservoir and the air-brake cylinder, and means actuated by the pressure in the air-brake cylinder for moving said plug in the reverse direction, in combination substantially as described.

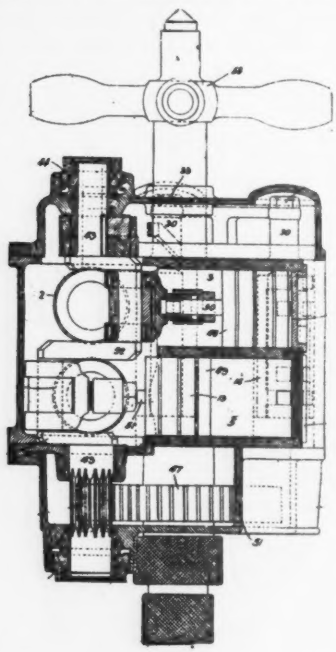
733,497. RIVETING-MACHINE. George E. Martin, Philadelphia, Pa., assignor to the Pedrick and Ayer Company, Plainfield, N. J. Filed Aug. 14, 1902. Serial No. 119,610.

733,917. SELF-PLAYING ORGAN AND PNEUMATIC ACTION THEREFOR. Joseph E. Prante, Chillicothe, Ohio, assignor of two-thirds to John M. Patridge and Henry Holberg, Wellston, Ohio. Filed July 7, 1902. Serial No. 114,557.

The combination, with a pneumatic for organs having a casing, of a block secured in the casing in communication with the pneumatic and having a dust-chamber, an air-channel extending from the chamber through the block, and a dust-discharge opening from the bottom of the chamber.

733,960. PNEUMATIC DRILL OR LIKE MACHINE. George H. Hayes, London, England, assignor to Chicago Pneumatic Tool Company, a Corporation of New Jersey. Filed Dec. 4, 1902. Serial No. 133,906.

A hand portable pneumatic tool of the type set forth, a fluid-pressure cylinder, a piston working therein, a crank-shaft connected to said piston, an oscillating controlling and reversing valve consisting of a single part ar-



ranged across or at right angles to said cylinder, a sleeve on the machine-handle, and means operatively connecting said valve and the sleeve whereby the valve may be moved longitudinally for the purpose of reversing the revolution of the crank-shaft and tool.

733,971. LIQUID RHEOSTAT OPERATED BY COMPRESSED AIR. Koloman de Kando, Budapest, Austria-Hungary. Filed May 25, 1901. Serial No. 61,916.

A liquid rheostat and a compressed-air conduit therefor, a throttle-valve in the conduit adapted to more or less cut off the air-supply from the rheostat and means in the electric circuit to control the movement of the valve.

733,986. ATTACHMENT FOR PNEUMATIC FEEDING-TRUNKS. Thomas R. Marsden, Oldham, England. Filed Mar. 7, 1903. Serial No. 146,700.

734,023. HEATING APPARATUS FOR CLOSED RECEPTACLES. John A. Waters, Stamford, Conn. Filed Aug. 4, 1902. Serial No. 118,313.

The combination with a heat-generator, of a plurality of ovens each having a vent, means for supplying air under pressure to the heat-generator, a pipe leading from the heat-generator and having branches to the individual ovens, a plurality of separate pipes for distributing the heated air to different locations within the ovens to enable articles therein to be uniformly heated, means for controlling the heated air admitted to each oven, and means for independently controlling the outlets from the different pipes in each oven.

734,028. AIR-PUMP MECHANISM FOR MOTOR-VEHICLES. Rollin H. White, Cleveland, Ohio, assignor to the White Sewing Machine Company, Cleveland, Ohio, a Corporation of Ohio. Filed Apr. 21, 1902. Serial No. 103,854.

An automobile, the combination of a fuel-tank, an air-pump, an engine, and means for connecting and disconnecting the engine and pump, with a pipe connecting said pump and tank and having a relief-opening, and valve-mechanism adapted to simultaneously establish communication through said pipe between the pump and tank and to close said relief-opening, and *vice versa*.

734,067. PNEUMATIC STACKER. Louis Holland-Letz, Chicago, Ill., assignor to the Plano Manufacturing Company, Chicago, Ill., a Corporation of Illinois. Filed Feb. 3, 1902. Serial No. 92,326.

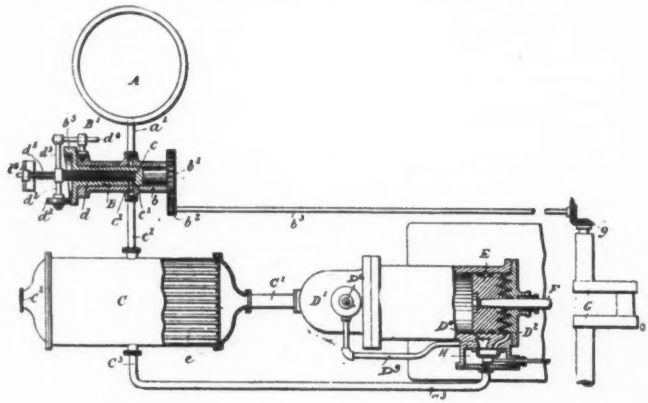
734,262. MUSICAL INSTRUMENT. William E. Haskell, Philadelphia, Pa. Filed Mar. 28, 1901. Serial No. 53,194.

A musical instrument, the combination with a pneumatic tracker-bar comprising the metal plate; of means to progress a perforated web with respect to said metal plate; a series of orifices in the front of said metal plate; a series of metal conduits; a series of metal nozzles, whose rear ends are respectively connected to the metal conduits and form continuations thereof, and whose front ends are seated in the metal plate, in respective communication with said orifices; each of said

metal nozzles being of greater area at its rear extremity than at its junction with said metal plate and the rear extremities of said metal nozzles, being alternately divergent in staggered relation with the axis of the series; and a casing member comprising upper and lower boards secured at their front edges to said tracker-bar and forming a chamber co-extensive with and inclosing said series of nozzles.

734,220. COMBINATION INTERNAL-COMBUSTION AND COMPRESSED OR LIQUID GAS OR COMPRESSED OR LIQUID AIR ENGINE. Frank Bryan, London, and Abel H. Bayley, Niton, Isle of Wight, England. Filed Feb. 26, 1901. Serial No. 48,973.

A liquid air or gas engine, the combination with the supply-reservoir and converter, of a movable measuring-chamber having ports adapted to alternately communicate with said reservoir and converter and automatically deliver the measured charge to the converter in direct opposition to the pressure in the converter when the pressure in the same is below the required working pressure.



734,265. TUNNEL CONSTRUCTION. David L. Hough, New York, N. Y., assignor to the United Engineering & Contracting Company, New York, N. Y., a Corporation of New York. Filed Feb. 7, 1903. Serial No. 142,287.

The combination with a tunnel-shield and a tunnel-lining, of a pneumatic bag packing interposed between the shield and the lining, and a stiffening-plate within the bag to hold it in shape when inflated.

734,319. PAINTING-MACHINE. John Grahn, Madison, Wis. Filed July 15, 1902. Serial No. 115,615.

A painting-machine, the combination of a brush provided with bristles and a pair of webs of flexible material disposed amid said bristles for discharging a painting fluid thereto, and means for connecting said flexible web with a source for supplying paint.

734,356. COOLING DEVICE FOR EXPLOSIVE ENGINES. Martin Offenbacher, Furth, Germany, assignor to The Firm of Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nurnberg A. G., Nuremberg, Germany. Filed Dec. 30, 1902. Serial No. 137,197.

A combination with an engine having a water-jacket, water-circulating pipes therefor, a compressed-air pipe connected with the circulating-pipes and valves in said circulating-pipes whereby water may flow into the packet or be forced therefrom.

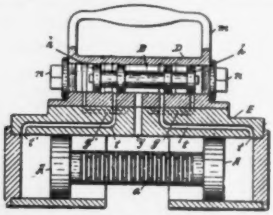
734,466. PNEUMATIC SHEET-FEEDING MACHINE. George F. Leiger, Chicago, Ill., assignor to himself and Lewis Benedict, Chicago, Ill. Filed June 3, 1901. Serial No. 62,959.

The combination with pneumatic sheet engaging and forwarding mechanism, a vacuum-chamber, a valve-box connected with said vacuum-chamber, and pipes connecting said pneumatic sheet engaging and forwarding mechanism with said valve-box and opening into the same, of a rotary valve seated in said valve-box and adapted by its rotation to open

and close the openings of said pipes into said valve-box at suitable intervals as said valve rotates, and mechanism for rotating said rotary valve.

734,276. PNEUMATIC TOOL. Foster M. Metcalf and Martin C. Abbey, Battlecreek, Mich. Filed Feb. 10, 1903. Serial No. 142,808.

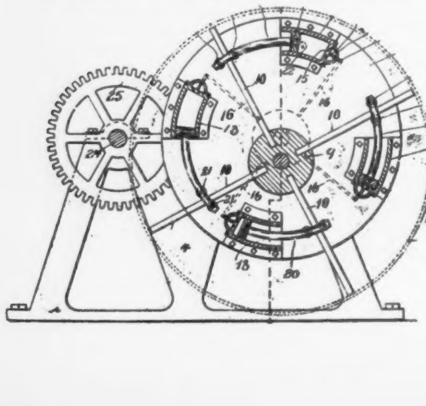
A pneumatic tool, the combination of two oppositely - arranged pressure - chambers, a double-headed piston having one of its heads oscillatingly mounted in each pressure-chamber, supply-chamber in communication with



each end of said pressure-chambers, an oscillating controlling-valve mounted in said supply-chamber adapted to control the admission of pressure to the ends of the pressure-chambers, a disk valve rotatably mounted to control the admission of pressure to the supply-chamber, a chuck-spindle rotatably mounted and connected with the disk valve and means carried by the main piston for operating the chuck and simultaneously the disk valve.

734,303. AIR-COMPRESSOR. George Code, Melrose, Mass., assignor, by direct and mesne assignments, to United States Atmospheric Oxygen Company, Boston, Mass., a Corporation of Maine. Filed Sept. 15, 1902. Serial No. 123,396.

A pumping apparatus comprising a rotatively-mounted cylinder and piston, and a rotatively-mounted actuator for said piston, one



axis of rotation being eccentric to the other, the cylinder being mounted with its bore in the direction of its path of travel.

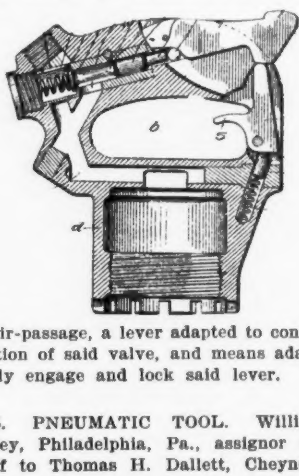
734,473. AIR-BRUSH. William H. Shepler, Chicago, Ill., assignor of five-eighths to Albert Ahrens and Charles Orchardson, Chicago, Ill. Filed July 28, 1902. Serial No. 117,278.

A device of the class described, the combination with a pigment-valve, and receptacle for a supply of pigment, means of connection between said receptacle and said valve, means for opening said valve, a nozzle for compressed air contiguous to said pigment-valve and means for opening and closing said nozzle, of a hollow chamber connected to said nozzle and having a fixed relation thereto and adapted to hold a supply of compressed air.

734,540. PNEUMATIC - DESPATCH - TUBE SYSTEM. Charles A. Gray, Kansas City, Kans., assignor to Gray Pneumatic Carrier Co., Kansas City, Mo., a Corporation of Missouri. Filed Feb. 13, 1903. Serial No. 143,271.

734,700. THROTTLE - VALVE LOCK FOR PNEUMATIC HAMMERS. Charles H. Haeseler, Easton, Pa., assignor to the Haeseler-Ingersoll Pneumatic Tool Company, New York, N. Y., a Corporation of West Virginia. Filed May 26, 1903. Serial No. 158,777.

A pneumatic hammer, the combination with the handle, of an air-passage in said handle, a valve controlling the pressure of air through

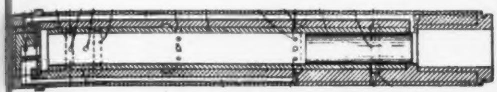


said air-passage, a lever adapted to control the operation of said valve, and means adapted to directly engage and lock said lever.

734,765. PNEUMATIC TOOL. William H. Soley, Philadelphia, Pa., assignor of one-half to Thomas H. Dallett, Cheyney, and

George A. Dallett, Philadelphia, Pa., trading as Thomas H. Dallett and Company, a Firm. Filed June 3, 1902. Serial No. 110,033.

A pneumatic tool, in combination a piston-chamber and piston therein, a valve-chamber and a main valve therein, a pilot, or supple-



mental valve in the piston chamber adapted to act in advance of the piston and connect one main-valve-operating passage with the piston-chamber.

734,773. MECHANICAL DEVICE FOR RECEIVING SAND AND DISCHARGING IT THEREFROM UNDER PRESSURE. William H. Stuart, Baltimore, Md., assignor to Economy Locomotive Sander Company, Baltimore, Md., a Corporation of Delaware. Filed July 26, 1902. Serial No. 117,213.

A sand-delivery device containing sand receiving and discharging passages in and through which a body of sand or other finely-comminuted mineral substance is introduced under atmospheric or higher pressure and discharged therefrom by fluid-pressure, said passages having their inner walls provided with a substantially smooth and non-oxidizable surface.

734,904. CONTROLLER FOR HYDRAULIC AIR-COMPRESSORS. William J. Linton, Woodstock, Canada, assignor to the Taylor Hydraulic Air Compressing Company, Limited, Montreal, Canada, a Corporation of Canada. Original application filed Feb. 21, 1900, Serial No. 6,044. Divided and this application filed Dec. 5, 1900. Serial No. 38,849.

An air-compressor of the class described means for automatically controlling the air-supply to said compressor. The combination with the air-supply pipes of a hydraulic air-compressor of the class described, of means for automatically controlling the passage of air through said air-supply pipes.

734,979. PNEUMATIC-ACTION FOR MUSICAL INSTRUMENTS. Horace T. Skelton, Cambridge, Mass. Filed Oct. 30, 1902. Serial No. 129,475.

735,005. APPARATUS FOR UNLOADING AND DISTRIBUTING STEEL RAILS. Henry Ware, Springville, N. Y. Filed Mar. 25, 1903. Serial No. 149,543.

The combination of a car, a pneumatic hoist suspended therefrom, means for operating said hoist from the air-brake system of the train, and a skid attached to one end of said car.

An invitation is extended by "Compressed Air" to all delegates attending the American Mining Congress to communicate items of interest especially in connection with their experiences in the Black Hills.